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John Haddy James

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The Journal of Bone and Joint Surgery

The Journal of
Bone and Joint Surgery

ANNOTATION

SURGERY OF THE HAND

In 1916 Biesalski and Mayer* described their experience of tendon transplantation in animals and in the same year Mayer† published a paper on the physiological method of tendon transfer. Two years later Bunnell‡ described the operation of tendon repair in the finger. From these beginnings and from the inspiration of such men as Bunnell, Kanavel, Koch and Mayer has arisen the wide and increasing interest shown in surgery of the hand. Bunnell's monumental work, in particular, has laid the solid foundation upon which the younger generation is building. In most countries of the world there are now small groups of surgeons developing this long neglected surgical field and achieving a high standard of result. The hand has become the focal point of interest in which the two specialities of orthopaedic and plastic surgery meet. A new body of surgeons is arising who, while maintaining their interest in general orthopaedic or plastic work, have a special interest in the hand. Great Britain is sharing in this advance, but much more requires to be accomplished if this country is to remain in the front line of progress.

Reconstruction of the hand, " the jewelry of orthopaedic surgery," as Bunnell called it, does not favour the system of combined operation that is accepted and indeed necessary in general limb surgery. It is unwise for more than one surgeon to work upon the complex anatomy of the hand, and thus create a division of responsibility, and those who practise hand surgery must be capable of all the duties of this work. There is no place here for the surgeon who can repair the skin but not the nerves, or the surgeon who can suture tendons but not restore skin defects. This new speciality not only demands a particular type of training and a high degree of craftsmanship, but it is probably true to say that it calls for a particular temperament, perhaps somewhat like that of a small boy who takes his toy to pieces in order to see how it works, and then has the patience to put it together again!

Several centres for hand surgery have been formed by individual effort in this country, and the patient with the crippled hand does not need to travel far to reach a service where his problem is not exceptional. Unhappily, it is a very different story for the patient who goes to the casualty department of many general hospitals. He may be cared for by a member of the junior staff who has had little, if any, special training. The operating theatres are too busy with major surgical work to allow for the intrusion of such a case, still classified as minor, but which may need as much care and skill as the abdominal emergencies which jeopardise life. The hand is unique in its combination of specialised tissues, the skin adapted for many forms of sensibility, the delicate gliding parts for precise movements and the powerful muscles and tendons for gripping. These tissues react badly to the oedema which follows injury, and

* Biesalski, K., and Mayer, L. (1916): Die physiologische Sehnenverpflanzung. Berlin: J. Springer.
† Mayer, L. (1916): The Physiological Method of Tendon Transplantation. I. Historical; Anatomy and Physiology of Tendons. II. Operative Technique. III. Experimental and Clinical Experiences. Surgery, Gynecology and Obstetrics, **22,** 182; 298; 472.
‡ Bunnell, S. (1918): Repair of Tendons in the Fingers and Description of Two New Instruments. Surgery, Gynecology and Obstetrics, **26,** 103.

the joint stiffness which so quickly appears is most difficult to overcome once it is established. Wounds, apparently trivial, may divide a tendon or nerve and lead to months of incapacity. Wounds that are left open to granulate heal with deep fibrosis and skin contractions which could have been avoided by the use of an immediate free skin graft or a suitably fashioned flap.

Rank and Wakefield* have recently drawn attention to the magnitude of the problem. In 1949, 30 per cent of all the injury benefits paid under the National Insurance Act of Great Britain for accidents and prescribed diseases were for injuries of the hand. Every year in the United States of America there are approximately 2,000,000 disabling work injuries and some 75 per cent affect the hand. In the State of Victoria industrial injuries reach a yearly average of 5,350, and, of this total, 1,950 consist of hand injuries.

The hand is one of man's most precious possessions, and the perfect co-ordination between brain and hand has determined man's destiny, and his place in nature. This symbol of man's power, this instrument of his perception, this mirror of his emotion; what is more versatile than the human hand, and what tool more necessary for the support of life? Great is the disaster when these attributes are impaired or lost by injury and disease.

There is need of a more acute sense of our responsibility for the care of these very common injuries and for an enthusiasm like that which led to the establishment of our fracture clinics. There are two ways in which the challenge can be met. Firstly by the formation of hand units attached to every accident service, and secondly by the training of young surgeons in this work, whether their determined career be orthopaedic or plastic surgery.

R. G. PULVERTAFT.

* RANK, B. K., and WAKEFIELD, A. R. (1953): Surgery of Repair as Applied to Hand Injuries, 3. Edinburgh and London: E. & S. Livingstone Ltd.

THE CHEMOTHERAPY OF ORTHOPAEDIC TUBERCULOSIS*

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"Streptomycin is a useful adjunct in the treatment of tuberculosis. This may well be an over-statement in tuberculosis of bone and joint, in which group we have little knowledge and less hope" (*Report to the Council on Pharmacy and Chemistry, Journal of the American Medical Association, November* 1947).

In this paper consideration can be limited to the results with streptomycin, para-amino-salicylic-acid and isonicotinic-acid-hydrazide with its relation 1-isonicotinyl-2-isopropyl-hydrazine. Neomycin (Tenth Chemotherapy Tuberculosis Conference 1951), Viomycin (Muschenheim 1951, Pitts *et al.* 1952), Terramycin (Tenth Chemotherapy Tuberculosis Conference 1951) and Pyrazinamide (Schwartz and Moyer 1952) are all either too toxic or have been shown to be ineffective. Thiosemicarbazone (Tenth Chemotherapy Tuberculosis Conference 1951, Reinhard 1950, Skavlem *et al.* 1951, Netzer *et al.* 1951, Colwell 1951) also has been found valueless in bone and joint disease.

ADMINISTRATION, TOXICITY, AND DRUG RESISTANCE

Para-amino-salicylic-acid—This compound, generally referred to as P.A.S., was introduced by Lehmann in 1946. It has been of limited usefulness in both pulmonary tuberculosis (Bogen *et al.* 1950, Steinlin and Wilhelmi 1948) and orthopaedic tuberculosis (Reinhard 1950). Reinhard showed, and Allaria and Goidanich (1952) confirmed, that it was inadequate for orthopaedic cases when used alone. Resistance develops in a high percentage of cases after its use for six months. Cocchi's method (Regli and Stäubli 1951) of prolonged and frequent intravenous infusions of P.A.S. has not been used in orthopaedic cases. Its most useful effect—prevention of the emergence of streptomycin-resistant strains when used with streptomycin—requires a dosage of at least ten to twenty grammes a day (Medical Research Council 1950). Benemid will reduce its rate of excretion and increase the blood concentration (Boger and Pitts 1950, Amatuzio *et al.* 1952, Boger and Strickland 1951) but little practical use has been made of this method of lowering the oral dosage. It often provokes toxic reactions (Warring and Howlett 1952, Thomas 1952, Pugh *et al.* 1952), but they are usually mild: loss of appetite, nausea, and gastric upset seem to occur equally whatever the method of administration—whether it be by liquid solution, cachets or keratin-coated granules. Calcium benzamido-salicylate, which decomposes to release P.A.S. after absorption, can be given as seven grammes of powder in suspension eight-hourly, but many patients dislike its muddy consistency although it is relatively tasteless.

Streptomycin—Streptomycin sulphate is less painful intramuscularly than the calcium salt. Comolli (1952) has recommended intra-arterial or even intra-aortic injections for acute infections. Because streptomycin acts best at a pH around 9·0 (Waksman and Schatz 1945) attempts have been made to obtain a high pH when using the drug. For tuberculosis of the knee Streeten (1949) gave intra-articular streptomycin with a buffered alkaline solution. Others have used similar methods for the pleura, pericardium and peritoneum (Staines and Cárdenas 1950, Streeten 1949, Bull *et al.* 1952).

A single daily dose was found to be as effective as divided doses. Two grammes, though more effective than one gramme, proved too toxic for continued use, and one gramme daily became the commonly accepted routine (Birath 1952, Tucker 1950, Tenth Chemotherapy

* An abstract of the Robert Jones Prize Essay, 1952.

Tuberculosis Conference 1951, Tucker 1952, Jawetz and Gunnison 1952, Hughes *et al.* 1951). By 1951 in America P.A.S. in doses of twelve grammes daily, with streptomycin one gramme twice a week, was stated to be as effective as streptomycin in daily doses of one gramme (Hughes *et al.* 1951). The most important toxic effects of streptomycin (Council on Pharmacy and Chemistry 1947) are, of course, those connected with the eighth nerve. Deafness is permanent, but vertigo can be compensated except in the dark. Vitamin B deficiency symptoms—smooth tongue, cheilosis and pellagra-like skin affections—can be treated by large doses of the B vitamins. Daily streptomycin when used alone has been shown to produce resistant strains after forty-two days in 35 per cent; after sixty days in 50 per cent; after 120 days in 75 per cent.

Isonicotinic-acid-hydrazide—This is commonly referred to as I.N.A.H. Dosage has varied between three and eight milligrams per kilogram of body weight per day. Toxic effects (British Medical Journal 1952, McConnell and Cheetham 1952, Hunter 1952) include rashes, fever, vitamin B deficiency symptoms and certain neurological effects upon the reflexes and bladder function. In sputum-positive pulmonary tuberculosis resistance has been shown to develop in 11 per cent after one month's treatment; in 52 per cent in two months; in 71 per cent in three months. Considerations of the rapidity of the development of resistance and further investigation at Guy's Hospital (Joiner *et al.* 1952) showed clearly that I.N.A.H. was no more suitable for use alone than P.A.S. or streptomycin, but that a combination of I.N.A.H. and streptomycin mutually would prevent development of resistance for a time. During a second three months of treatment resistant strains do appear and it is very likely that, even though P.A.S. itself may not have great anti-tuberculosis effect, it should be used with streptomycin and I.N.A.H. to decrease still further the rate of emergence of mutants resistant to any of the drugs. Organisms have remained resistant to I.N.A.H. through at least six sub-cultures (Guy's Hospital Group Report 1952). Streptomycin and I.N.A.H. together give a higher bactericidal effect than either alone (Rist 1952). In macrophage tissue culture with ingested tubercle bacilli, I.N.A.H. has an inhibitory concentration of 0·05 micrograms per millilitre whereas streptomycin requires 10 micrograms and P.A.S. 100 micrograms (Mackaness 1952, Mackaness and Smith 1952). This ability of I.N.A.H. to penetrate cells and affect the tubercle bacilli within them is obviously of very great value. Streptomycin and I.N.A.H. together double the rate of killing by either drug alone, and will actually sterilize a culture, which again neither drug will do alone. This synergistic effect has been confirmed by others (Goulding and Robson 1952).

Resistance—The discovery at the Mayo Clinic (Karlson *et al.* 1949, Rothstein 1952, Harris *et al.* 1952) that streptomycin and P.A.S. when given together delayed the emergence of strains resistant to either opened new possibilities. It is clear, however, that no drug will prevent resistance to another drug unless the organism is sensitive to the first drug. It is useless to give P.A.S. and streptomycin in alternate weeks or alternate months to prevent resistance (Medical Research Council 1950, Dye *et al.* 1952).

Alexander (1952) showed that streptomycin resistance tends to develop to a high degree in a small number of large steps. I.N.A.H. probably does the same. Penicillin produces resistance by a large number of smaller steps. The same worker (Alexander 1952) has made sensitive organisms immediately resistant by exposure to certain desoxyribo-nucleic acids obtained from resistant strains. There is thus a chemical basis to the resistant state.

Any lesion contains a mixture of organisms of variable resistance, and at times different organs of the same host may contain organisms of different degrees of resistance. Moreover, if streptomycin is discontinued, resistant bacilli may tend to die out and the sensitive strains again to predominate (Lecocq and Linz 1952). Therefore a moderate degree of resistance does not mean that further streptomycin is necessarily useless. Mond (1951) has claimed sputum conversion by the use of streptomycin in patients from whom the laboratory had grown resistant organisms.

Secondary infection and antibiotics—Jawetz and Gunnison (1952) have shown that the use of two or more antibiotics against secondary infection requires careful consideration. Antibiotics can act synergistically or antagonistically, or merely side by side without any effect upon one another. The bactericidal antibiotics penicillin, streptomycin, I.N.A.H., bacitracin, neomycin, and the bacteriostatic antibiotics aureomycin, chloromycetin, terramycin, P.A.S., and the sulphonamides, if used together, may be ineffective. The bactericidal antibiotic which acts upon actively dividing organisms may be prevented from so doing by the bacteriostatic antibiotic inhibiting cell division. Thus aureomycin or chloromycetin may diminish the effect of penicillin; terramycin has been shown to diminish the effect of I.N.A.H. against tuberculosis. Streptomycin on the other hand may help penicillin to cure staphylococcal infection by preventing the emergence of penicillin-resistant staphylococci. It may therefore be necessary, if streptomycin and I.N.A.H. are being used, and another antibiotic is proposed against a secondary invader, to test in the laboratory the effect of a combination of the drugs upon the secondary infecting organism.

General conclusions on the administration of antibiotic drugs—The available evidence supports the following conclusions.

1. No antibiotic for tuberculosis should ever be given alone.
2. Streptomycin in doses of one gramme daily and I.N.A.H. in doses of four milligrams per kilogram of body weight daily form the best chemotherapeutic combination at present available.
3. Since many cases will require chemotherapy for more than three months and the above combination cannot be guaranteed to prevent resistance developing beyond that time, it is at present better always to use P.A.S. in a dosage of at least fifteen grammes per day with the other two drugs.
4. The antibiotic treatment of secondary infection may require detailed laboratory investigations if antagonism between drugs is to be avoided.
5. Patients admitted with reactivation of the disease frequently give a history of injury. An instruction to patients after discharge from hospital to report any reasonably serious injury, so that they may receive a timely course of chemotherapy, may prevent or diminish such relapses.
6. Intra-arterial antibiotic therapy and a combination of anti-tuberculous drugs with the use of cortisone are methods which may be of value in the future in certain cases (Small 1951).

TREATMENT OF SINUSES WITH INTRAMUSCULAR STREPTOMYCIN

In the early days of chemotherapy sinuses were treated without particular consideration of the underlying lesion. On this basis from 1948 onwards a series of forty patients was collected at the Royal National Orthopaedic Hospital and given a three months' course of streptomycin in doses of one gramme daily in combination with ordinary conservative treatment. Dosage was constant and diagnosis certain; any patient requiring surgical intervention was excluded from the series. Successful healing was defined as healing occurring during the three months' course with no breakdown in the subsequent two years or more. The cases have in fact been followed for three to four years. Twenty-eight cases were retained in the series, the others being discarded for various valid reasons. The few patients under ten years of age received three-quarters of a gramme daily instead of one gramme. Table I indicates the sites of disease and summarises the results.

SUMMARISED ANALYSIS OF THE FAILURES

The cases in which healing was not obtained were studied to determine whether a cause for the failure could be identified.

Spine—Calcified and caseous masses in the soft tissues near L.5 and S.1 and probably sequestra anterior to L.5.

Spine—Sequestra and calcified caseous masses in region of lumbar spine.

Spine—Lesion T.6–7 with collapse and good apposition and some new bone formation anteriorly. Second lesion T.10–11 with still a narrow intervertebral space and cavitation into both vertebral bodies. It was this lesion which produced the sinus. The reason for the persistence of the sinus is not clear but it had developed as a result of the active disease in this area and did not close until quiescence.
Spine—Sequestrum under the lower surface of L.4. A bony bridge was visible anteriorly in the lateral view and there was some persistence of a disc space.
Spine decompression wound—General honeycombing of vertebral bodies by tuberculous disease was seen at operation.
Greater trochanter—The answer was given by the fact that he healed after curetting.
Hip—Discharge continued because of two small sequestra on the inner side of the femoral neck.
Spine—Presence of a bony bridge and a sequestrum.
Spine—Gross involvement of bone and soft tissues, for many months before treatment, by a very virulent toxin-producing staphylococcus of the same phage type as the staphylococcus present in a case of chronic osteomyelitis in a nearby bed in the ward.
Knee—Sequestrum in head of the fibula.

TABLE I

SITE OF LESION AND RESULTS IN TWENTY-EIGHT CASES OF PERSISTENT SINUS TREATED BY STREPTOMYCIN

Site of lesion	Under 10 years	10–20 years	Over 20 years	Total	Failed	Greatly improved	Healed
Hip	1	1	0	2	1	0	1
Knee	1	0	1	2	0	1	1
Pubis	0	0	1	1	0	0	1
Greater trochanter	0	2	1	3	1*	0	2
Spine	0	4	12	16	5	2	9
Spinal decompression wounds	0	1	1	2	0	1	1
Skin tuberculomata	0	0	2	2	0	0	2
	2	8	18	28	7	4	17
Converted to per cent				100	25	14·3	60·7

* Converted to success by surgical intervention.

It is important to note that whereas radiological reasons were found for many of the failures the radiographs in the " successful " cases did not show similar evidence. It should therefore have been possible to foresee the results of treatment with a considerable degree of accuracy. Many series with about the same proportion of successes have been published. Similar reasons for failure have been adduced but many were not followed for long enough (Pulaski *et al.* 1949, DeForest Smith and I-Sen-Yu 1950, Bickel *et al.* 1948, Galland 1949, Harvard Davis 1949, Report to the Council on Pharmacy and Chemistry 1948, Report to the Council on Pharmacy and Chemistry 1947, Jellinek 1949, Fourth Streptomycin Conference 1947, Brock 1947, Bosworth *et al.* 1950, Rocher and Cuenot 1949). Ahern (1950) published a series of eighteen cases treated by injecting from a quarter of a gramme to one gramme of streptomycin daily by catheter down the sinus. He obtained healing in two to sixteen weeks, and eventually, in 1952, had succeeded in forty of forty-nine cases; others (Allaria and Goidanich 1951, Zarotti 1951) used similar methods.

The next stage was reached when Harken *et al.* (1948) and Cincotti *et al.* (1949) published papers in which they reported the use of intramuscular streptomycin as a cover for the surgical opening and clearing of sinuses. They packed the laid open sinuses with iodoform gauze for two days; thereafter they used azochloramide dressings with daily irrigation and

subsequently " revised " and closed the wound after seven to ten days. They claimed 90 and 100 per cent successes with firm healing in six weeks.

In our own series it became clear that if healing was going to occur the discharge had very greatly lessened by the end of the second month of intramuscular streptomycin. It has already been shown that it is frequently possible to determine from the radiographic appearance which patients are likely to heal with intramuscular streptomycin alone and which will require open surgery under streptomycin cover. It should be possible to obtain healing in over 90 per cent of cases of persistent sinus by chemotherapy if surgery is employed in a proportion of them—namely, those which demand surgery on radiological grounds and those which do not show evidence of healing within two months of intramuscular streptomycin.

INTRAMUSCULAR STREPTOMYCIN FOR CLOSED BONE AND JOINT LESIONS

In 1948 an experiment was planned to see whether streptomycin would show any unequivocally r cognisable effect upon the natural history of conservatively treated tuberculosis of the hip and knee. Criteria for acceptance in this series were: 1) treatment to be for initial disease and not in relapse; 2) no surgical intervention to be undertaken apart from biopsies; 3) the same conservative treatment to be used as had previously been given in the Royal National Orthopaedic Hospital to such cases without streptomycin; 4) chemotherapy course to be standardised to a three months' period with dosage of half a gramme daily for children under five years, three-quarters of a gramme for children of five to ten years, and one gramme for patients over ten years; 5) diagnosis to be proved. The clinical material used for this study is summarised in Table II.

TABLE II

PATIENTS WITH CLOSED SKELETAL TUBERCULOSIS TREATED BY STREPTOMYCIN

Total number of patients treated by streptomycin	53
Patients treated in relapse	11
Patients admitted with advanced disease or with disease nearly healed	6
Patients operated upon before assessment possible	8
Diagnosis proved non-tuberculous	3
Total discarded	28
Total for assessment	25
Hips 18 Knees 7	

The three months' streptomycin treatment was given as soon as the diagnosis was confirmed. The surgeon treated his cases without reference to the chemotherapy. He determined when to cease conservative treatment or remobilise upon clinical and radiological evidence as always before. A series of forty cases of tuberculous hip disease from the hospital records with a similar range of length of history before treatment was chosen for comparison.

Truly objective points for comparison between the two series were then sought. The assessment of clinical improvement is often based upon personal opinion. Radiological decision as to ultimate healing is also difficult. There is, however, one point in the series of radiographs of a case which can be fixed. During treatment osteoporosis occurs as the combined effect of the acute inflammatory disease, bone destruction and the immobilisation. At a certain stage, as the disease becomes quiescent, the bone outlines and trabecular pattern begin to reappear. The length of time between the beginning of conservative treatment and

the quarterly radiograph in which this radiological improvement could be clearly defined was taken as the first objective point of comparison.

The second comparison about which there can be no argument is the degree of ultimate mobility.

TABLE III

COMPARATIVE RESULTS OF TREATMENT OF TUBERCULOSIS OF THE HIP WITH AND WITHOUT STREPTOMYCIN

	Months	Average (*months*)
Without streptomycin (40 cases)		
Length of history before treatment . .	1 to 24	8
Conservative treatment before reossification	8 to 28	15
With streptomycin (18 cases)		
Length of history before treatment . .	1 to 42	8
Conservative treatment before reossification	3 to 14	

RESULTS

Tuberculosis of the hip—Table III shows the time taken for reossification in the series treated by streptomycin and in the control series. Table IV shows the range of movement regained in the patients treated by streptomycin. In Figures 1 and 2 the mobility regained in the two series is compared.

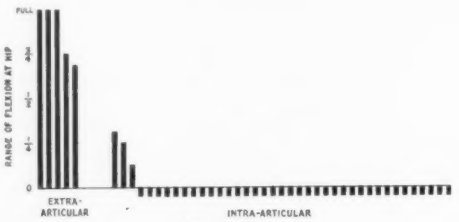

FIG. 1

Range of flexion after conservative treatment for tuberculosis of the hip without chemotherapy. (Forty-four patients).

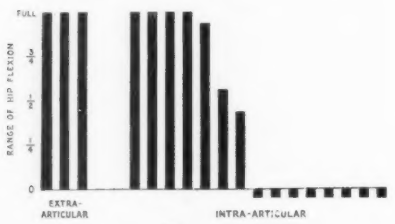

FIG. 2

Range of flexion after conservative treatment for tuberculosis of the hip with streptomycin. (Eighteen patients. Average follow-up period 41 months).

It will be seen that the average duration of conservative treatment, before the beginning of reossification, was reduced from fifteen months to seven months and that approximately 40 per cent of cases with intra-articular hip disease regained a range of movement not seen in the pre-streptomycin series. In both series good results were obtained in cases of extra-articular hip disease and the difference was therefore probably less significant.

TABLE IV

RANGE OF MOVEMENT AT THE HIP IN EIGHTEEN CASES OF TUBERCULOSIS TREATED BY STREPTOMYCIN

Patient	Age at onset (*yrs.*)	Duration of symptoms before conservative treatment (*months*)	Duration of total conservative treatment (*months*)	Conservative treatment after streptomycin (*months*)	Range of movement	Follow-up after streptomycin (*months*)	Remarks
Intra-articular lesions							
1	12	12	5	0	Nil	53	
2	12	12	14	9	Full	34	
3	2½	18	12	9	Flexion Full Abduction 45° Rotation Full	42	
4	8	30	15	6	Flexion 135° Abduction 35° Adduction 30° Rotation 15 and 15	43	
5	13	7	16	12	Flexion Full Adduction Full Abduction Full Medial rotation Nil Lateral rotation 15°	50	
6	9	24	6	3	15°–80°	28	Relapsed 1 year after streptomycin
7	3½	1	15	9	Nil	48	
8	4¾	8	10	5	Nil	44	Arthrodesis 18 months after streptomycin
9	3	1	16	9	Nil	44	
10	9	9	12	9	Nil	34	
11	22	42	18	14	Nil	48	
12	2½	24	18	13	Nil	60	
13	6	2	13	9	Flexion 10°–85° Abduction 0°–30° Adduction 0°–10° Medial rotation Nil Lateral rotation Slight	35	
14	25	1 week	9	4	Nil	47	Relapsed at 1 year
15	4½	2	10	6	Full	22	
Extra-articular lesions							
16	10¾	4	11	7	Almost full	30	
17	1½	1	6	2	Full both hips	44	
18	3	5	4	0	Full	44	

TABLE V

RANGE OF MOVEMENT AT THE KNEE IN SEVEN CASES OF TUBERCULOSIS TREATED BY STREPTOMYCIN

Patient	Age at onset (*years*)	Duration of symptoms before conservative treatment (*months*)	Total duration of conservative treatment (*months*)	Conservative treatment after streptomycin (*months*)	Range of movement	Follow-up after streptomycin (*months*)
Intra-articular focus (erosion of one femoral condyle)						
19	3½	3	12	4	30°–Full	45
Synovial tuberculosis						
20	1½	2	8	3	Full	54
21	1¾	10	4	0	Full	46
22	6	24	4	0	Full	49
23	17	3	5	1	0°–90°	42
24	2½	10	4	1	Full	32
25	2¼	6	10	5	Full	26

Tuberculosis of the knee—The results in synovial tuberculosis of the knee are again much better than those ordinarily expected in a similar consecutive series without streptomycin. Table V shows the range of movement regained in the seven cases treated with streptomycin: Figure 3 shows these results graphically.

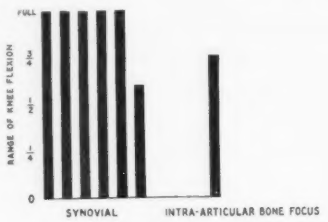

FIG. 3

Range of knee movement in seven cases of tuberculous arthritis treated by streptomycin. (Average follow-up period 42 months.)

Duration of treatment—At the end of four years' observation of streptomycin treatment the length of time our surgeons had in fact found it necessary to continue their conservative treatment was noted. Again the figures were compared with a series from pre-streptomycin records. These observations are shown in Table VI.

There had been a spontaneous and unconscious reduction in the average conservative treatment by about 50 per cent. The average conservative treatment for synovial disease of the knee was only seven months when streptomycin was used.

Only three patients have relapsed and those were not ones in whom good mobility had been obtained. They were the three patients who had received less than six months' conservative treatment after the end of the streptomycin course. There is obviously a limit to the reduction in conservative treatment which is possible.

TABLE VI

DURATION OF CONSERVATIVE TREATMENT REQUIRED FOR TUBERCULOSIS OF THE HIP TREATED WITH AND WITHOUT STREPTOMYCIN

	Average duration of treatment (*months*)
Without streptomycin (50 cases)	
Extra-articular lesions	21
Intra-articular lesions	24
With streptomycin (18 cases)	
Extra-articular lesions	8
Intra-articular lesions	13

FIG. 4

Case 4—Before treatment.

FIG. 5

Case 4—Three years after discharge from hospital.

FIG. 6
Case 12—At diagnosis.

FIG. 7
Case 12—One month after beginning streptomycin treatment.

FIG. 8
Case 12—Two and a half years later.

ILLUSTRATIVE CASES

Case 4. *Intra-articular hip disease with restoration of* 135° *of flexion*—This child was eight years old at the time of onset of the disease. Figure 4 shows the worst state and Figure 5 the late result. The child had led a normal life free from splintage for the last three years.

Case 12. *Recovery of femoral head and neck after acute disease*—Figure 6 shows the hips of a three-years-old boy at the time of diagnosis. Seven months later and one month after the beginning of streptomycin the situation had deteriorated; there were gross destruction, abscess formation and

FIG. 9
Case 17—At age nineteen months. Bilateral extra-articular lesions.

FIG. 10
Case 17—Three years later. Full hip movement was retained.

subperiosteal new bone down the femoral shaft indicating the spread of disease (Fig. 7). The surprising degree of recovery (Fig. 8) was not, of course, accompanied by restoration of movement.

Case 16. *Bilateral extra-articular lesions with grossly destructive disease; preservation of the hip joints with full movement*—Figure 9 shows the condition at the time of diagnosis at the age of nineteen months. Both epiphysial plates were involved and there was much subperiosteal new bone on the right femoral shaft. Figure 10 shows the condition three years later. The child had led a normal unrestricted life for the past two years.

Case 19. *Re-formation of a seemingly destroyed femoral condyle*—Figure 11 shows the knee of a four-years-old child with an eight months' history of disease at the beginning of streptomycin treatment. Figure 12 shows the recovery eleven months after the course. She retained 75 degrees of movement.

FIG. 11
Case 19—Before treatment.

FIG. 12
Case 19—Eleven months after streptomycin treatment.

Conclusion—Streptomycin given for three months, in a dosage of half to one gramme daily according to age, is able significantly to alter the natural history of conservatively treated tuberculosis of the hip and knee in children.

SYNOVIAL TUBERCULOSIS OF THE KNEE IN YOUNG ADULTS TREATED BY COMBINED INTRAMUSCULAR AND INTRA-ARTICULAR STREPTOMYCIN AND ORAL P.A.S. WITHOUT SPLINTING

This group of patients with tuberculosis of the knee, with a long history, absence of bone destruction or loss of joint space, and preservation of a good range of movement, was thought to require a different line of approach. Synovectomy under streptomycin cover in two patients greatly reduced the previous range of movement. It was therefore decided to prohibit weight bearing but to allow freedom in bed. Streptomycin in doses of one gramme intramuscularly was given daily except on those days when one gramme of streptomycin was injected into the knee joint (see Table VII). P.A.S. was given orally in quantities of fifteen grammes a day divided into six doses. Treatment continued for three months. There was some variation in the frequency of intra-articular streptomycin (Table VII). At the end of the course of chemotherapy there was usually some residual effusion, and some increase of effusion often occurred after an injection. But after the termination of the course of intra-articular injections the effusions all absorbed rapidly. The results in the four cases studied are shown in Table VII and further details are summarised below.

TABLE VII

RESULTS OF TREATMENT OF SYNOVIAL DISEASE OF THE KNEES IN ADULTS BY STREPTOMYCIN

(In all cases the diagnosis was confirmed pathologically)

Case number	Age at treatment	Sex	Length of history before treatment	Mobility before treatment	Time without weight bearing	Mobility at time of follow-up	Clinical state of knee	Time since course of streptomycin (*months*)
26	24	M	5 years	10°–110°	4 months	5°–120°	No synovial thickening. No effusion, heat or spasm	36
27	20	F	6 years	0°–110°	5 months	0°–120°	Normal	32
28	20	M	15 months	10°–100°	7 months	0°–135°	Normal	16
29	35	F	3 months	0°– 80°	5 months	Full	Normal	13

Intra-articular streptomycin

Case 26—Four times only in three months
Case 27—Twice weekly for three months
Case 28—Once weekly for three months
Case 29—Once weekly for four weeks
Twice weekly for nine weeks

SUMMARISED CASE NOTES

Case 26—Five years' chronic synovial effusion has been succeeded by a fluid-free joint with full movement.

Case 27—Six years' chronic effusion in a girl of twenty who had for this reason never been able to work has been succeeded by a normal-looking knee with full movement. She now works a full day as a librarian. The fluid at biopsy was very cloudy with flecks of fibrin.

Case 28—Chronic effusion has been succeeded by a normal knee with full range of movement. The fluid was turbid and full of flecks of fibrin. Tubercle bacilli could still be grown from it at the end of one month's treatment but not thereafter.

Case 29—This older woman has done very well and actually increased her range of movement from 0–80° before treatment to a full range thirteen months after treatment.

Streptomycin content of synovial fluid and blood after intra-articular administration—Investigation of joint fluid and blood after intra-articular streptomycin gave the following results. 1) There is an effective streptomycin level still present in the joint a week after intra-articular injection. 2) The intra-articular injection of one gramme of streptomycin will produce variable but effective blood levels for something between eight and twelve hours afterwards. 3) It is possible that streptomycin injected intramuscularly may be concentrated in the synovial fluid of an inflamed joint.

SPINAL DISEASE TREATED CONSERVATIVELY AND WITH STREPTOMYCIN, OR WITH STREPTOMYCIN AND P.A.S.

This study was begun later than those of the hip and knee. It is not proposed to give results in detail for reasons of space and because full assessment would require a longer follow-up. The following conclusions, however, seem justifiable at present.

1. In comparing cases treated by chemotherapy with the records of earlier cases treated without chemotherapy it is essential to break down the series into groups according to the age of the patient and the site of disease.

2. A follow-up to the end of 1952 suggested that a three months' course of streptomycin or streptomycin and P.A.S. had not increased the rapidity of radiological improvement. (The question of mobility naturally does not arise.) It therefore seemed necessary to give chemotherapy for six months at least for spinal disease. When only two drugs are used the question of resistance arises, because streptomycin and P.A.S. together frequently induce resistance after the first three months. The same is true when streptomycin and I.N.A.H. are used. All three drugs therefore are now given together, with streptomycin daily for the first three months and three times a week for the second three months. Fifteen grammes of P.A.S. are given daily for the whole period and I.N.A.H. (200 milligrams with a reduction for children, keeping the daily dose to about 4 milligrams per kilogram body weight) is also given throughout. This series with all three drugs was only begun twelve months ago.

PRESENT CLAIMS (1953) AND QUESTIONS REQUIRING A DEFINITIVE ANSWER

Synovial disease of the knee. *Children*—Excellent results are reported here with a three months' course of streptomycin and an average duration of splintage of seven months. Confirmation with the additional use of the new antibiotics is required.

Chronic disease in young adults—Streeten's (1949) use of buffered alkaline solutions with streptomycin intra-articularly and the paper on intra-articular streptomycin by Ahern and Arden (1952) have been mentioned. The particular cases quoted in both papers prove little. Our own series strongly suggests that intra-articular injections combined with intramuscular streptomycin and oral P.A.S.—and now, of course, I.N.A.H.—without splinting but with bed rest, may well be sufficient for these patients. The method requires further trial.

Intra-articular bone foci at the hip—The results in the series reported here, in which conservative treatment was supplemented by streptomycin alone, should be improved upon by the administration also of P.A.S. and I.N.A.H. A strict comparison should be made between the results from this treatment and those obtainable by Wilkinson's method of partial synovectomy and curettage of bone foci. It might be possible in time to differentiate radiologically the cases that are more likely to respond to one or the other method.

Abscesses—In the opinion of many recent writers chemotherapy has its greatest value in restoring to tuberculosis-inoculated tissues their powers of healing and thereby allowing tuberculous bone and joint disease to be tackled upon the ordinary principles of surgery. Massart (1950), Winterhoff and Weber (1948), Hoover (1950), Sérée and Dettloff (1950), Cotrel (1950), Roaf (1952), Macrae (1952), Wilkinson (1950) and Orell (1951) from many different countries have all pressed for the direct attack upon abscesses, whether secondarily infected or not, under chemotherapy cover. In a valuable Swedish symposium Ostman (1951) claimed twenty-five out of twenty-seven cases successfully healed by primary intention after drainage of abscesses under streptomycin cover. He even drained three sacro-iliac abscesses and inserted bone grafts immediately afterwards, and obtained primary healing. Carl Hirsch (1951) reported fourteen cases in which paravertebral abscesses were drained. The lumbar abscesses were approached either by a ventral or a dorsal retroperitoneal route. In each case the abscess was wiped out and necrotic bone was curetted from the vertebral bodies. Hirsch also found (personal communication) that he could safely fill the defects with bone chips if he left streptomycin and penicillin in the wound and arranged for systemic cover by

streptomycin, P.A.S. and penicillin. Kastert (1951) in Germany has used similar methods, and has irrigated the vertebral lesion with streptomycin daily through a fine rubber catheter for six weeks after operation. He allows the resumption of ordinary activities in a corset after four months. Many American papers (Bosworth and Wright 1952, Harris *et al.* 1952) are largely statistical but Evans (1952), from an analysis of 238 cases, concluded on good evidence that surgery need not await quiescence of disease, that multiple active lesions can be dealt with, and that abscesses do not forbid arthrodesis or grafting. Deroy and Fisher (1952) gave details of their technique for opening closed bone lesions, converting them to open lesions with gauze packing after clearance of diseased bone, and promoting healing under chemotherapy cover. Sacro-iliac disease, with curettage and implantation of bone chips, and thoracic and lumbar spine disease, of which they reported twenty-one cases, were radically dealt with in the same fashion. They wrote of the frequent incidence of rapid spontaneous vertebral fusion after operation. All these papers antedate the use of I.N.A.H.; with its aid such methods should be even safer.

In tuberculosis of the greater trochanter Lindahl (1951) reduced the number of days' stay in hospital by radical operation under chemotherapy cover from an average of 265 days with conservative treatment alone to sixty-three days with chemotherapy and operation. He obtained primary healing and followed his cases for two years before publication.

It is obvious that all these radical methods of dealing with abscesses, vertebral disease, sacro-iliac disease and juxta-articular bone foci in the limbs require confirmation, but such " combined operations " may greatly diminish the time spent in hospital: more mobility may be obtained in limb joints; further destructive disease after the onset of treatment, particularly in the spine, may be prevented; and, in particular, the type of case in which prolonged abscess formation and successive involvement of vertebral body after vertebral body by subligamentous spread—possibly with sinus formation and secondary infection—may become a thing of the past. The value and the safety of immediately packing the cavity with bone chips after curetting bone lesions requires further study. Finally, attention should be drawn to the group of thoracic spinal disease in small children. It is here in particular that gross destruction of a number of vertebral bodies at an early age produces such severe deformity of the thorax with respiratory embarrassment, stunting and the dangers of paraplegia. How far would early radical surgery under chemotherapy be helpful?

Sinuses—Emphasis has shifted from consideration of the sinus to that of the underlying cause. Thirty per cent of relapses were found in Brock's (1947) patients treated by streptomycin when they were followed up after five years; chemotherapy for the sinus alone may be a short-sighted policy. A different mental approach is required in considering an advanced or relapsed case and a full plan must be thought out. In such cases no surgery may be better than too little surgery if an unsuccessful operation is to be avoided for the patient.

CONCLUSIONS

Streptomycin and the newer antibiotics have already belied the pessimistic agnosticism of 1947. In certain instances, notably in disease of the knee and hip and in some cases with draining sinuses, it appears that they are sufficient to produce a quiescence which may be a cure. For the rest it remains to map out in detail what has in part been explored. In particular it is essential to confirm how far antibiotics enable surgeons to treat tuberculosis upon the basic principles applicable to other infections of bone without fear of secondary infection: where there is diseased bone, to remove it: where there is pus, to relieve the tension and evacuate it. The surgeon fears not so much the infection itself as the inability of the tuberculous soil ordinarily to deal with secondary infection. With the control of the diseased soil the risk should be no greater than that of any other surgery of bone.

The early case and the advanced case; age and site of disease; these and other variables

must subdivide basic method. What is the best application of the new " combined operation " to a child of three with thoracic Pott's disease and a globular abscess ? What is the wisest plan for a man of forty with old disease in his lumbar vertebrae and discharging sinuses ? We begin to see what we could do. At the present the question still remains: What should we do?

The patients reported personally have been under the care of the surgeons of the Royal National Orthopaedic Hospital and I acknowledge most gratefully their cooperation in the planned investigations. I have learned much from my surgical colleagues, in particular Mr John Cholmeley, and also from Dr E. H. Allen of the Radiological Department. To the Streptomycin in Tuberculosis Committee of the Medical Research Council we were indebted for supplies of streptomycin which enabled the investigations to be begun in 1948. The Pathological and Photographic Departments and the Librarian of the Institute of Orthopaedics have been most helpful and I am also much indebted to Mrs Kay Boyce and Miss Vera Brown for their conscientious secretarial help.

REFERENCES

AHERN, R. T. (1950): Tuberculous Sinuses Treated with Streptomycin Locally. Lancet, **i,** 443.

AHERN, R. T., and ARDEN, G. P. (1952): Intra-articular Streptomycin in Tuberculosis of the Knee. British Medical Journal, **i,** 466.

ALEXANDER, H. E. (1952): Prevention of Emergence of Resistance. (Centre International de l'Enfance Seminar on Antibiotics and Children's Diseases.) P. 197. London: Lange, Maxwell and Springer.

ALLARIA, A., and GOIDANICH, I. F. (1951): Osservazioni Cliniche e Biologiche su due Anni di Terapia Streptomicinica nella Tuberculosi Osteo-articolare. Chirurgia degli Organi di Movimento, **35,** 295.

ALLARIA, A., and GOIDANICH, I. F. (1952): Il Trattamento della Tuberculosi Osteoarticolare con Acido Para-amino-salicilico (PAS) Solo ed Associato alla Streptomicina. Chirurgia degli Organi di Movimento, **37,** 103.

AMATUZIO, D. C., BREITENBUCHER, R., and FALK, A. (1952): The Effect of Benemid in Enhancing PAS Blood Levels. Transactions of the 11th Conference on the Chemotherapy of Tuberculosis, p. 221. Washington: Veterans Administration—Army—Navy.

BICKEL, W. H., YOUNG, H. H., PFEUTZE, K. H., and NORLEY, T. (1948): Streptomycin in Tuberculosis of Bone and Joint. Journal of the American Medical Association, **137,** 682.

BIRATH, G. (1952): Guided Symphysis: Functional Prophylaxis in Exudative Pleurisy and Pneumothorax Fluid. American Review of Tuberculosis, **66,** 134.

BOGEN, E., LOOMIS, R. N., and WILL, D. W. (1950): Para-aminosalicylic Acid Treatment of Tuberculosis: a Review. American Review of Tuberculosis, **61,** 226.

BOGER, W. P., and PITTS, F. W. (1950): Plasma Concentrations of *p*-Aminosalicylic Acid (PAS) Increased by *p*-(Di-*n*-propylsulfamyl) Benzoic Acid. Science, **112,** 149.

BOGER, W. P., and STRICKLAND, S. C. (1951): " Benemid ": Preliminary Assessment of its Toxicity in Man. Transactions of the 10th Conference on the Chemotherapy of Tuberculosis (Streptomycin Conference), p. 292. Washington: Veterans Administration—Army—Navy.

BOSWORTH, D. M., PIETRA, A. Della, and FARRELL, R. F. (1950): Streptomycin in Tuberculous Bone and Joint Lesions with Mixed Infection and Sinuses. Journal of Bone and Joint Surgery, **32–A,** 103.

BOSWORTH, D. M., and WRIGHT, H. A. (1952): Streptomycin in Bone and Joint Tuberculosis. Journal of Bone and Joint Surgery, **34–A,** 255.

BROCK, B. L. (1947): Streptomycin in the Treatment of Draining Tuberculous Sinuses. Journal of the American Medical Association, **135,** 147.

BULL, W. F., MCMAHON, D. L., ERWIN, F. V., and DYE, W. E. (1952): The Effect of Total Environmental Acidity on Inhibition or on Apparent Stimulation of Bacterial Growth by Chemotherapeutic Agents. Transactions of the 11th Conference on the Chemotherapy of Tuberculosis, p. 244. Washington: Veterans Administration—Army—Navy.

CINCOTTI, J. J., SALZBERG, A. M., BOONE, E. W., and KELLEY, J. B. (1949): Posterior Tuberculosis Sinuses of Vertebral Origin: Wound Revision and Closure with Streptomycin Permitting Early Spinal Fusion. New England Journal of Medicine, **241,** 193.

COLWELL, C. A. (1951): Summary of Studies on Development of Resistance of M. Tuberculosis to Tibione. Transactions of the 10th Conference on the Chemotherapy of Tuberculosis (Streptomycin Conference), p. 205. Washington: Veterans Administration—Army—Navy.

COMOLLI, A. (1952) L'Emploi des Antibiotiques par Voie Artérielle chez l'Enfant. (Centre International de l'Enfance Seminar on Antibiotics and Children's Diseases.) P. 283. London: Lange, Maxwell and Springer.

COTREL, Y. (1950): La Streptomycine dans les Tuberculoses Ostéo-articulaires. Journal des Praticiens, **64,** 532.

DEFOREST SMITH, A., and I-SEN-YU, H. (1950): Streptomycin Combined with Surgery in the Treatment of Bone and Joint Tuberculosis. Journal of the American Medical Association, **142,** 1.

DEROY, M. S., and FISHER, H. (1952): The Treatment of Tuberculous Bone Disease by Surgical Drainage Combined with Streptomycin. Journal of Bone and Joint Surgery, **34–A,** 299.

DYE, W. E., HOWARD, O. P., and JENKINS, E. D. (1952): Discussion of Table XII: Emergence of Bacterial Resistance and Correlation with Data from Previous Conferences. Transactions of the 11th Conference on the Chemotherapy of Tuberculosis, p. 203. Washington: Veterans Administration—Army—Navy.

Editorial (1952): Isoniazid in Pulmonary Tuberculosis. British Medical Journal, **ii,** 764.

EVANS, E. T. (1952): Tuberculosis of the Bones and Joints: with Special Reference to the Influence of Streptomycin and the Application of Radical Surgical Techniques to Certain Effects and Complications of the Tuberculous Lesion. Journal of Bone and Joint Surgery, **34–A,** 267.

GALLAND, M. (1949): Streptomycine et Tuberculose Osseuse. Revue d'Orthopédie, **35,** 56.

GOULDING, R., and ROBSON, J. M. (1952): Isoniazid in the Control of Experimental Corneal Tuberculosis. Lancet, **ii,** 849.

HARKEN, D. E., CINCOTTI, J. J., and ARICO, J. F. (1948): Streptomycin and Secondary Closure in the Treatment of Tuberculous Sinuses. Surgical Clinics of North America, **28,** 1,627.

HARRIS, R. I., COULTHARD, H. S., and DEWAR, F. P. (1952): Streptomycin in the Treatment of Bone and Joint Tuberculosis. Journal of Bone and Joint Surgery, **34–A,** 279.

HARVARD DAVIS, R. (1949): Streptomycin in the Treatment of Tuberculous Sinuses: review of 11 cases. Lancet, **ii,** 982.

HIRSCH, C. (1951): Surgical Interventions on Paravertebral Tuberculous Abscesses. Acta Orthopaedica Scandinavica, **21,** 211.

HOOVER, M. J., Jun. (1950): Treatment of the Tuberculous Psoas Abscess. Southern Surgeon, **16,** 729.

HUGHES, F. J., MARDIS, R. E., DYE, W. E., and TEMPEL, C. W. (1951): Combined Intermittent Regimens in the Treatment of Non-miliary Pulmonary Tuberculosis: a Comparison of SM Every Third Day and PAS Daily with SM Every Third Day and PAS Every Third Day. Transactions of the 10th Conference on the Chemotherapy of Tuberculosis (Streptomycin Conference), p. 67. Washington: Veterans Administration—Army—Navy.

HUNTER, R. A. (1952): Confusional Psychosis with Residual Organic Cerebral Impairment Following Isoniazid Therapy. Lancet, **ii,** 960.

JAWETZ, E., and GUNNISON, J. B. (1952): Studies on Antibiotic Synergism and Antagonism: a Scheme of Combined Antibiotic Action. Antibiotics and Chemotherapy, **2,** 243.

JELLINEK, K. (1949): Streptomycin in the Treatment of Extrapulmonary Tuberculosis: Early Results. New England Journal of Medicine, **240,** 680.

JOINER, C. L., MACLEAN, K. S., PRITCHARD, E. K., ANDERSON, K., and COLLARD, P. (1952): Isoniazid in Pulmonary Tuberculosis: its Use with and without Streptomycin. Lancet, **ii,** 843.

KARLSON, A. G., PFEUTZE, K. H., CARR, D. T., FELDMAN, W. H., and HINSHAW, H. C. (1949): The Effect of Combined Therapy with Streptomycin, Para-aminosalicylic Acid and Promin on the Emergence of Streptomycin-resistant Strains of Tubercle Bacilli: a Preliminary Report. Proceedings of the Staff Meetings of the Mayo Clinic, **24,** 85.

KASTERT, J. (1951): Die tuberkulostatische Herdebehandlung der Wirbeltuberkulose. Fortschritte auf dem Gebiete der Röntgenstrahlen, **74,** 535.

LECOCQ, E., and LINZ, R. (1952): Sensibilité et Résistance du Bacille Tuberculeux à l'Hydrazide Isonicotinique. (Centre International de l'Enfance Seminar on Antibiotics and Children's Diseases.) P. 159. London: Lange, Maxwell and Springer.

LEHMANN, J. (1946): Kemoterapi av Tuberkulos: *p*-Aminosalicylsyra (PAS) och Närstaende Derivats Bakteriostatiska Effekt pa Tuberkel-Bacillen Jämte Djurexperimentella och Kliniska Försök med PAS. Svenska Läkartidningen, **43,** 2,029.

LINDAHL, O. (1951): Tuberculosis of the Great Trochanter with Special Reference to the Treatment by Chemotherapeutics. Acta Orthopaedica Scandinavica, **21,** 221.

MCCONNELL, R. B., and CHEETHAM, H. D. (1952): Acute Pellagra during Isoniazid Therapy. Lancet, **ii,** 959.

MACRAE, D. E. (1952): Personal Communication.

MACKANESS, G. B. (1952): The Action of Drugs on Intracellular Tubercle Bacilli. (Centre International de l'Enfance Seminar on Antibiotics and Children's Diseases.) P. 164. London: Lange, Maxwell and Springer.

MACKANESS, G. B., and SMITH, N. (1952): The Action of Isoniazid (Isonicotinic Acid Hydrazide) on Intracellular Tubercle Bacilli. American Review of Tuberculosis, **66,** 125.

MASSART, R. (1950): A Pros du Traitement des Suppurations des Tuberculoses Ostéo-articulaires par la Streptomycine. Bulletins et Mémoires de la Société des Chirurgiens de Paris, **40,** 129.

MOND, E. R. (1951): Discussion of Table 1–C, Streptomycin-resistant Cases Treated under Protocol Since the Seventh Conference (April 1949). Transactions of the 10th Conference on the Chemotherapy of Tuberculosis (Streptomycin Conference), p. 52. Washington: Veterans Administration—Army—Navy.

MUSCHENHEIM, C. (1951): Viomycin: a Clinical Report. Transactions of the 10th Conference on the Chemotherapy of Tuberculosis (Streptomycin Conference), p. 154. Washington: Veterans Administration—Army—Navy.

NETZER, S., SCHWARTZ, J. A., and DAVIS, J. D. (1951): Further Clinical Experiences with Amithiozone (Tibione). Transactions of the 10th Conference on the Chemotherapy of Tuberculosis (Streptomycin Conference), p. 142. Washington: Veterans Administration—Army—Navy.

ORELL, S. (1951): Chemotherapy and Surgical Treatment in Bone and Joint Tuberculosis. Acta Orthopaedica Scandinavica, **21,** 190.

OSTMAN, P. (1951): Combined Surgica and Chemo-therapy of Abscesses in Bone and Joint Tuberculosis: Early Results. Acta Orthopaedica Scandinavica, **21,** 204.

PITTS, F., O'DELL, E., HOWARD, O., SCHMIDT, C., and CHAMBERS, J. (1952): Clinical and Laboratory Toxicity Encountered during Intermittent Viomycin Therapy. Transactions of the 11th Conference on the Chemotherapy of Tuberculosis, p. 279. Washington: Veterans Administration—Army—Navy.

PUGH, D. L., EDWARDS, G. F., MCLAREN, R. G., and JONES, E. R. (1952): Toxic Psychiatric Manifestations in the Treatment of Tuberculosis with Sodium Para-aminosalicylate. Tubercle, **33,** 369.

PULASKI, E. J., CONNELL, J. F., Jun., KOWALCZYK, A., and SEELEY, S. F. (1949): Streptomycin in Surgical Infections. VII. Nonpulmonary Tuberculosis (Lymph Nodes, Urinary Tract, Bone and Peritoneum). Annals of Surgery, **129,** 90.

REGLI, J., and STÄUBLI, C. (1951): Über Methodik und Komplikationen der intravenösen PAS-Infusionen. Schweizerische Medizinische Wochenschrift, **81,** 1,305.

REINHARD, W. E. (1950): Therapie der Knochen- und Gelenktuberkulose mit *p*-Aminosalicylsäure. Beiträge zur Klinik der Tuberkulose, **104,** 179.

REPORT on Results of Intramuscular Streptomycin Courses (1947): Minutes of the 4th Streptomycin Conference.

REPORT to the Council on Pharmacy and Chemistry (1947): The Effects of Streptomycin on Tuberculosis in Man. Journal of the American Medical Association, **135,** 634.

REPORT to the Council on Pharmacy and Chemistry (1948): Streptomycin in the Treatment of Tuberculosis. Journal of the American Medical Association, **138,** 584.

REPORT to the Streptomycin in Tuberculosis Committee of the Medical Research Council (1950): Intermittent Dosage in the Treatment of Pulmonary Tuberculosis with Streptomycin. British Medical Journal, **i,** 1,224.

RIST, N. (1952): Chimiothérapie Antituberculeuse. Les Associations in vitro de l'Isoniazide à la Streptomycine et au P.A.S. Difficultés d'Interprétation. (Centre International de l'Enfance Seminar on Antibiotics and Children's Diseases.) P. 148. London: Lange, Maxwell and Springer.

ROAF, R. (1952): Tuberculosis of the Spine (Correspondence). Journal of Bone and Joint Surgery, **34-B,** 163.

ROCHER, L., and CUENOT, A. (1949): La Streptomycine Locale dans les Tuberculoses Abcédées, Revue d'Orthopédie, **35,** 46.

ROTHSTEIN, E. (1952): Combined Streptomycin and PAS Sensitivity Studies Using M. Tuberculosis. Transactions of the 11th Conference on the Chemotherapy of Tuberculosis. p. 239. Washington: Veterans Administration—Army—Navy.

SCHWARTZ, W. S., and MOYER, R. E. (1952): Pyrazinamide (Aldinamide) in the Effect of Tuberculosis (a Preliminary Report). Transactions of the 11th Conference on the Chemotherapy of Tuberculosis, p. 302. Washington: Veterans Administration—Army—Navy.

SÉRÉE, R., and DETTLOFF, M. (1950): Resultats de 18 Mois de Streptomycinothérapie chez les Tuberculeux Osseux. Semaine des Hôpitaux de Paris, **26,** 4,482.

SITA LUMSDEN, E. G., and SWOBODA, J. A. F. (1952): Isoniazid in the Treatment of Pulmonary Tuberculosis. Tubercle, **33,** 322.

SKAVLEM, S., HUMPHREY, H. I., WOLIUNG, R. W., and SPRINKLE, R. P. (1951): Thiosemicarbasones [*sic*] in Tuberculosis: Report of Treatment in 63 Cases. Transactions of the 10th Conference on the Chemotherapy of Tuberculosis (Streptomycin Conference), p. 120. Washington: Veterans Administration—Army—Navy.

SMALL, M. J. (1951): Favorable Response of Sarcoidosis to Cortisone Treatment. Transactions of the 10th Conference on the Chemotherapy of Tuberculosis (Streptomycin Conference), p. 264. Washington: Veterans Administration—Army—Navy.

STAINES, E., and CARDENAS, C. (1950): Streptomycin plus Alkalinization of the Pleural Cavity in the Treatment of Tuberculous Empyema. Journal of Thoracic Surgery, **19,** 891.

STEINLIN, H., and WILHELMI, E. (1948): Chemotherapie der Tuberkulose mit *p*-Aminosalicylsäure. Schweizerische Medizinische Wochenschrift, **78,** 1,219.

STREETEN, D. H. P. (1949): Tuberculosis of Joints and Serous Membranes: Treatment with Local Alkalinization and Streptomycin Administration. South African Medical Journal, **23,** 777.

THOMAS, J. H. (1952): A Case of Recurrent Jaundice due to PAS. Tubercle, **33,** 329.

TRANSACTIONS of the 10th Conference on the Chemotherapy of Tuberculosis (Streptomycin Conference) (1951): "Pilot Studies"—Terramycin, Viomycin, PAS Granules, Other Pilot Studies, Hemagglutination Test, p. 150. Washington: Veterans Administration—Army—Navy.

TRANSACTIONS of the 10th Conference on the Chemotherapy of Tuberculosis (Streptomycin Conference) (1951): Tuberculosis of the Lymph Glands, and of Bone, Joint and Cartilage VA Streptomycin Protocol, p. 365. Washington: Veterans Administration—Army—Navy.

TUCKER, W. B. (1950): Streptomycin and Tuberculosis: a Progress Report from the Cooperative Study of the Veterans Administration, Army and Navy. Transactions of the Forty-fifth Annual Meeting of the National Tuberculosis Association, p. 77. New York: National Tuberculosis Association.

TUCKER, W. B. (1952): The Effect of Certain Variables in the Chemotherapy of Pulmonary Tuberculosis. Transactions of the 11th Conference on the Chemotherapy of Tuberculosis, p. 42. Washington: Veterans Administration—Army—Navy.

WAKSMAN, S. A., and SCHATZ, A. (1945): Streptomycin—Origin, Nature and Properties. Journal of the American Pharmaceutical Association (Scientific edition), **34,** 273.

WARRING, F. C., Jun., and HOWLETT, K. S., Jun. (1952): Allergic Reactions to PAS. Transactions of the 11th Conference on the Chemotherapy of Tuberculosis, p. 192. Washington: Veterans Administration—Army—Navy.

WILKINSON, M. C. (1950): Curettage of Tuberculous Vertebral Disease in the Treatment of Spinal Caries. Proceedings of the Royal Society of Medicine (Section of Orthopaedics), **43,** 114.

WINTERHOFF, E. H., and WEBER, W. D. (1948): Streptomycin in the Treatment of Tuberculous Abscesses and Sinuses. Surgical Clinics of North America, **28,** 1,613.

ZAROTTI, R. (1951): La Terapia Streptomicinica nella T.B.C. Osteoarticolare Infantile. Chirurgia degli Organi di Movimento, **36,** 465.

CHEMOTHERAPY OF TUBERCULOSIS OF BONES AND JOINTS*

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The assessment of therapeutic remedies for tuberculosis is notoriously difficult: many remedies in the past have enjoyed popular favour but have been forgotten; many papers have been written on calcium or tuberculin or gold, but who now refers to them? These thoughts must have been in the minds of the Medical Research Council in 1946 when they undertook to plan trials of streptomycin in pulmonary tuberculosis (Medical Research Council 1948), because they determined to use for the test only patients having a similar type of disease and that a type not suitable for other forms of therapy, and that for controls there should be a parallel series of patients treated only by bed rest. They were able to draw on the large pulmonary tuberculosis population of the London County Council and the Middlesex County Council but found after three months that there were not enough suitable patients in these areas and so extended their recruitment into Scotland and Wales and the Midlands. No such method is possible for the solitary investigator working from material in a single hospital.

In the absence of any such method, considerable difficulties present themselves. The variety of lesions in skeletal is much greater than that in pulmonary tuberculosis, not only as each joint is affected but according to the degree that associated lesions are present. In pulmonary tuberculosis the radiographic appearance gives early information about onset of disease, about healing, and accurate information about the extent. This is not true of skeletal tuberculosis, in which radiographic changes lag behind clinical: the degree of disease is not faithfully represented in the radiograph of a tuberculous joint and as the processes of disease and repair are slow it is difficult to find critical criteria of the time of healing. It has seemed best to the author therefore not to attempt too fine a review of his patients but to compare different groups of patients in bulk, and to assess what changes in treatment have been made possible by the introduction of chemotherapy and antibiotics. It is hoped to show that this method has given valuable information. In addition, evidence is available of the appearance of joints at operation of patients who have received courses of antibiotics.

The principal antibiotic studied in this essay is streptomycin sulphate. This was given to adults in doses of one gramme intramuscularly every day for ninety days. Proportionately smaller doses were given to children. In the early stages of its use intra-articular injections of 200 milligrams at weekly or biweekly intervals were also given, but this method was abandoned as the repeated trauma to the joint seemed to cause synovitis to persist. The use of para-amino-salicylates (P.A.S.) in combination with streptomycin was limited to adult patients who had associated pulmonary tuberculosis because it is known that tubercle bacilli in pulmonary lesions develop resistance to streptomycin unless P.A.S. is also given. Those who had no associated pulmonary tuberculosis were not given P.A.S. because evidence was lacking that the tubercle bacilli in skeletal lesions developed resistance, and the amount of benefit derived from the addition of P.A.S. did not seem to warrant the long course needed of a drug which, in the early days at any rate, was unpleasant to take. In addition to a study of the effects of streptomycin in skeletal tuberculosis a short series of patients treated with iso-nicotinic acid hydrazide has been studied and the results will be described. At present it is the author's practice to prescribe a combination of streptomycin and iso-nicotinic acid hydrazide as advocated by Joiner *et al.* (1952) in their treatment of pulmonary lesions.

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By this method it is claimed that the greatest therapeutic benefit is obtained from each drug. Not sufficient time has elapsed to assess this method, but, from evidence which will appear, there is reason to suppose that the effects of antibiotic treatment are not curative, unless used in conjunction with other methods of treatment, such as surgery.

COMPARISON OF PATIENTS TREATED BY CONSTITUTIONAL TREATMENT AND ANTIBIOTICS ONLY

The records were investigated of patients who had been discharged from a long-stay open-air hospital, from the beginning of 1947 until October 1952, after treatment for skeletal tuberculosis.

From these patients, groups were selected of patients who had been treated by streptomycin and those who had not, both groups receiving constitutional treatment. Only patients suffering from tuberculosis of the spine, hip or knee were included in this part of the survey because only these were sufficiently numerous to form groups large enough for comparison.

Tuberculosis of the lumbar spine—The first step taken was to compare two groups of patients who had been treated for tuberculosis of the lumbar spine. Patients in both groups were discharged home in a spinal brace at a time when the disease seemed to have passed the active progressive phase, when recalcification and hardening of the radiographic appearance of carious areas was beginning and when other evidence indicated that the patient was getting the better of the disease. Before the introduction of antibiotic treatment the adult patient was discharged home after approximately a year's treatment to continue convalescence at home. In the two groups with tuberculosis of the lumbar spine, one of whom had been treated by streptomycin, there were two matters of which comparison could be made. The first was the duration of treatment necessary in hospital: whether streptomycin treatment had radically altered that. The second was the radiographic appearance of the patients' spines approximately a year after discharge. It was thought best to make comparison of radiographs taken a year after discharge, rather than at the time of discharge, because the healing processes would by then be more advanced and be therefore more comparable. By this means an approximate comparison between the two groups seemed possible, though the patients who did not receive streptomycin were slightly favoured as some follow-up radiographs of a slightly longer period were used. The comparison of these results is summarised in Table I.

TABLE I

COMPARISON OF RESULTS OF TREATMENT OF PATIENTS WITH TUBERCULOSIS OF THE LUMBAR SPINE

	Number of patients	Duration of treatment (*months*)	Radiographic appearance a year or more after discharge		
			Unsound ankylosis	Sound fibrous ankylosis	Bony ankylosis
With streptomycin	25	12·4	1	5	4
Without streptomycin	30	13·0	1	14	8

The figures in the table show that there was little difference in the duration of treatment of the two groups of patients. It will be noted that in the figures of radiographic appearances a year or more after discharge, there are only ten patients about whom information is available in the streptomycin-treated group. This is because most patients with tuberculosis of the lumbar spine who have received full courses of treatment have not yet been followed up for a year. This group of patients, with a relatively benign type of spinal tuberculosis, was one of the last groups selected for streptomycin treatment as it became more readily available.

The follow-up radiographic appearances in both groups were reassuring. Only one patient in each group has so far required readmission for further treatment: each had unsound fibrous ankylosis. Four out of ten streptomycin-treated patients, or 40 per cent, developed bony ankylosis compared to eight out of twenty-three patients, or 35 per cent, who were not treated with streptomycin. This may indicate a slight benefit in the streptomycin-treated group of patients but the results of treatment in the two groups do not differ greatly.

Tuberculosis of the thoracic spine—Next a comparison was made between two groups of patients suffering from tuberculosis of the lower thoracic or thoraco-lumbar spine: patients in one group had received streptomycin in addition to constitutional treatment. These also were compared for duration of treatment and for the extent of healing visible radiographically approximately a year after discharge. As from the groups with tuberculosis of the lumbar spine, from these groups also patients who had had posterior spinal fusions were excluded. In the two groups of patients with tuberculosis of the thoracic spine, however, there is a discrepancy caused by the exclusion also of some of the patients with more chronic types of disease who were treated with streptomycin but who also had curettage of the vertebral lesion, an operation which will be mentioned again later. The exclusion of these patients favours the streptomycin-treated group. The comparison of the two groups is seen in Table II.

TABLE II

COMPARISON OF RESULTS OF TREATMENT OF PATIENTS WITH TUBERCULOSIS OF THE THORACIC AND THORACO-LUMBAR SPINE

	Number of patients	Average duration of treatment (*months*)	Radiographic appearances a year or more after discharge		
			Unsound ankylosis	Sound fibrous ankylosis	Bony ankylosis
With streptomycin	21	11.9	2	6	3
Without streptomycin	30	13·7	6	10	3

It may be remarked in passing that the radiographic appearances of the group treated without streptomycin are flattering because after a year fourteen out of twenty, or 70 per cent, showed a stable ankylosis, yet in the author's experience after a four-years' follow-up a stable ankylosis in this group of patients is found in less than 60 per cent. For the purposes of this investigation, however, the Table shows sufficiently clearly that there was no great difference in the results of the two groups if allowance is made for the exclusion of some of the patients with the worst disease from the streptomycin-treated group who, if they had been included, would probably have increased the numbers in that group who developed an unsound ankylosis.

Tuberculosis of the hip and knee—It was possible also to compare groups of patients who were suffering from tuberculosis of the hip or tuberculosis of the knee and who were treated by a combination of constitutional treatment and arthrodesis, or, for tuberculosis of the hip, displacement osteotomy as an alternative to arthrodesis. Those who received such treatment with a full course of streptomycin in addition are compared with those treated without streptomycin. Only the duration of treatment in the patients of each group was compared because the operative treatment would obscure any late streptomycin effects. The duration of treatment is shown on Table III.

It will be seen that the duration of treatment for active tuberculosis of the hip or knee requiring displacement osteotomy or fusion has been diminished by the introduction of streptomycin. The reduction of duration of treatment is probably more than the figures indicate because it was effected gradually. The stabilisation operation can be performed

earlier owing to the security, produced by streptomycin, from miliary dissemination and secondary septic infection; tuberculous tissues operated upon also heal quicker. Nevertheless there must be a limit to the process of reducing the duration of treatment, because, though the local lesion may do very well, the prognosis depends as much on the incidence of associated tuberculous lesions elsewhere.

TABLE III

COMPARISON OF DURATION OF TREATMENT FOR TUBERCULOSIS OF THE HIP OR KNEE BY MEANS OF CONSTITUTIONAL TREATMENT AND STABILISATION OPERATION, WITH OR WITHOUT STREPTOMYCIN

	Tuberculosis of the hip			
	Number of children	Duration of treatment (*months*)	Number of adults	Duration of treatment (*months*)
Without streptomycin	8	25·9	9	16·6
With streptomycin	6	20·5	9	14·4
	Tuberculosis of the knee			
			Number of adults	Duration of treatment (*months*)
Without streptomycin			11	9·3
With streptomycin			8	7·5

Discussion—The late mortality in skeletal tuberculosis has been due to three main causes (Harris and Coulthard 1942). Miliary tuberculosis and secondary septic infection were responsible in pre-antibiotic days for half the late mortality: the introduction of antibiotics should materially diminish this part of the mortality rate. Most of the other half was due to death from associated tuberculous lesions: there is no evidence that antibiotics have diminished mortality from this cause.

The following particulars emphasise the need for caution in assessing the effects of antibiotic treatment. They refer almost entirely to streptomycin sulphate.

1) Twelve patients were admitted who had previously, at other hospitals, received adequate streptomycin treatment (ten patients had received treatment for more than eighty days). All these patients had quite active disease on admission. One man who had received thirteen weeks' streptomycin treatment and six weeks' combined isoniazid treatment for tuberculosis of the spine had, on admission, bilateral psoas abscesses, one containing six pints of pus, the other two pints.

2) Two patients had before admission been treated for tuberculous meningitis, in the presence of an associated skeletal lesion. Both recovered after approximately six months' streptomycin treatment. Both patients required full treatment for their skeletal disease subsequently. Although the meningitis had recovered there was gross active disease in the hip joint of one patient with tubercle bacilli in the pus, and there was typical active tuberculosis in the tarsus of the other patient.

3) Five patients admitted for recent fresh skeletal lesions had previously had a full course of streptomycin for the treatment of pulmonary tuberculosis.

4) Four patients treated for skeletal tuberculosis received full courses of streptomycin, but later developed fresh disease in another part of the skeleton.

5) Six patients who received a full course of streptomycin for skeletal disease later required readmission for reactivation of the disease in the old lesion.

These particulars do not include a smaller group of patients who were thought to have benefited from streptomycin administered before admission, who subsequently required less treatment than usual. But in combination with the details given in Tables I, II and III, in which the duration of treatment is compared for evidence of any rapid ameliorative power of streptomycin, they seem to show that streptomycin may be of assistance in the treatment of skeletal tuberculosis but is not by itself a major curative agent. There is no evidence to show that it can supplant constitutional treatment either to cure the local lesion or to improve the prognosis for reactivation of the disease either locally or in some other situation.

STREPTOMYCIN AND SURGERY OF SKELETAL TUBERCULOSIS

Thus far an attempt has been made to assess the value of streptomycin as a therapeutic agent by itself for skeletal tuberculosis. An attempt will next be made to show how antibiotics may provide the means by which the treatment of skeletal tuberculosis is immeasurably improved when used as an adjuvant to surgery. First it is necessary to consider that streptomycin in miliary forms of tuberculosis is considered to be of much value, and reports to this effect have appeared in the literature (National Tuberculosis Association 1949). Its beneficial effect on the treatment of tuberculous sinuses was also recognised. The threat of secondary septic infection of tuberculous joints had been diminished by the use of sulphonamides and penicillin. It seemed possible therefore that the miliary and septic complications of operation might be avoided and the door opened to successful surgery of the tuberculous lesion itself. That such surgery was necessary was the logical conclusion reached in the views of such pathologists as Medlar (National Tuberculosis Association 1949), who wrote that streptomycin treatment of tuberculosis was successful in the guinea pig because the disease was rapid in that animal and necrosis was not a marked feature: but necrosis was a prominent feature of tuberculosis in man, and when that occurred the disease was not controlled by streptomycin. A similar conclusion was reached as a result of the report of the Federal Security Agency (1952) on the "evaluation of streptomycin treatment in a series of skeletal tuberculous patients." The conclusion was that "the data appear to substantiate the thesis that because of the relative avascularity of bony lesions and because a tuberculous focus is usually isolated by fibrous tissue walls, little streptomycin reaches the skeletal lesion." Boyd (1929), describing the pathology of skeletal tuberculosis, stated that "a tuberculous obliterating endarteritis followed later by a periarteritis is a very constant feature." It follows therefore that ischaemic necrosis is part of the pathology of tuberculosis and that unless a pathway is opened surgically antibiotics cannot have access to the lesion.

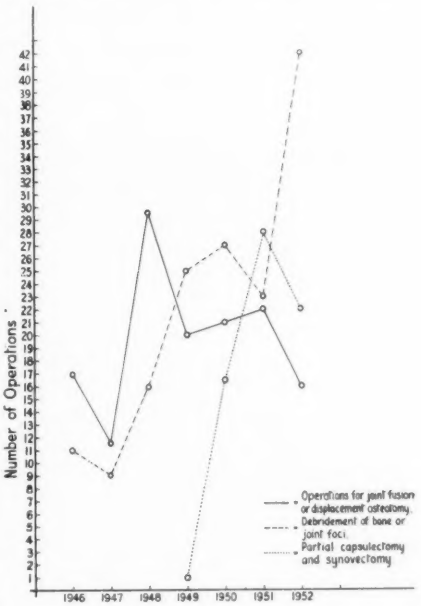

FIG. 1

Operative treatment of skeletal tuberculosis 1946–1952.

It is not the purpose of this paper to describe at length the methods of operative treatment that have been developed since the introduction of antibiotics. It was the practice of the author for many years to treat certain lesions such as tuberculosis of the tarsus or the wrist by curettage but a long preliminary period of constitutional treatment was first required to

establish resistance. Later, displacement osteotomies for tuberculosis of the hip were performed even when the disease was still active; and healing followed. Excision of the tuberculous knee in the stage of sluggish activity had long been practised. The advent of antibiotics increased the confidence with which such operations could be performed even on major joints. The total number of operations for skeletal tuberculosis, exclusive of operations on abscesses and sinuses, in the author's practice rose from twenty-eight in 1946 to seventy-seven in 1951: the increase was mainly due to operations into tuberculous tissues for the purpose of curetting necrotic foci or of removing oedematous tissues in which the vessels were blocked by endarteritis. The graph shown in Figure 1 shows how the numbers of these operations have increased.

TUBERCULOSIS OF THE SPINE

Hippocrates wrote, in the translation quoted by Major (1939): "The vertebrae of the spine, when contracted into a lump behind from disease, for the most part cannot be remedied, especially when the gibbosity is above the attachment of the diaphragm to the spine." The modern view about the difficulty of curing some patients with tuberculosis of the thoracic spine is the same. Cleveland and Bosworth (1942) described the incidence and effects of ischaemic necrosis in tuberculosis of the spine, and stress has also been laid on its importance by Capener (1947). Swett, Bennett and Street (1940) studied the late results of treatment of 350 patients with spinal tuberculosis and found that sound healing seldom occurred in the presence of a persistent perispinal abscess. They advocated evacuation of such abscesses. A persistent perispinal abscess is most often found in the thoracic spine. According to Watson-Jones (1949) pus under pressure has a very harmful effect on bone. For all of these reasons the author has been using streptomycin as a safeguard to enable him to operate on twenty-eight patients with persistent spinal granuloma or abscess. Pus under pressure has been found on several occasions, most significantly in young children with early lower thoracic disease. The amount of necrosis found usually exceeds expectations. The results of this operation are given in Table IV. By success is meant cessation of progressive caries and the development of a stable ankylosis; by incomplete success is meant sound healing of the lesion operated upon but relapse in another part of the spine: by failure is meant some extension of the disease after operation. The operation combined with antibiotic therapy seems the surest way of arresting the progress of the disease. Illustrative radiographs are shown in Figures 2 and 3.

TABLE IV

TREATMENT OF TUBERCULOSIS OF THE SPINE BY CURETTAGE OF THE VERTEBRAL BODIES. RESULTS UP TO JULY 1952

	Number of patients treated	Successes	Incomplete successes	Failures	Average duration of treatment (*months*)
Adults					
First admissions	8	7	1	0	11·6
Readmissions	8	7	0	1	7·5
Children	5	4	0	1	26

TUBERCULOSIS OF THE HIP

There are three main elements to be considered in tuberculosis of the hip: the subchondral bone, the synovial membrane and the capsule. There is ordinarily free vascular communication between these three (Davies 1946). That there is concomitant infection of the synovial membrane and the ends of the long bones has been emphasised by Allison and Ghormley (1931) and by Mortens (1948). In most tuberculous hips the vitality of the subchondral

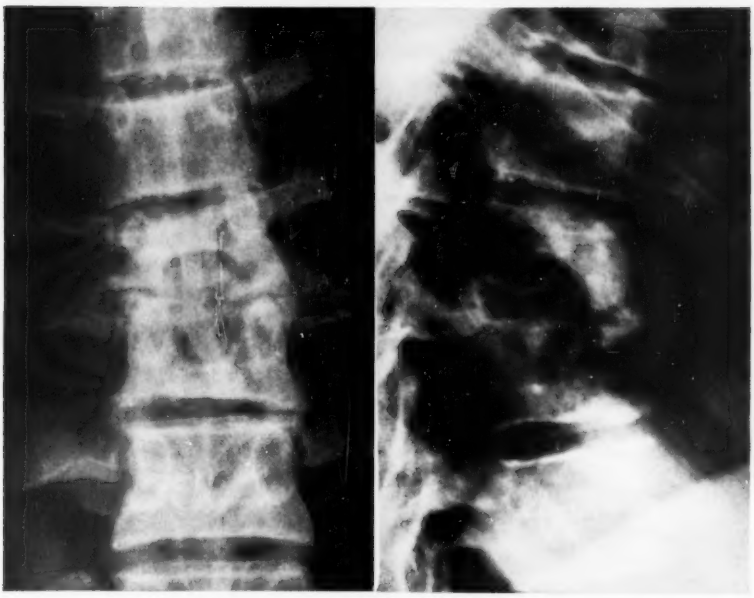

FIG. 2

Tuberculous lesion of thoracic spine with perispinal abscess. Curettage of the lesion was undertaken six months after these radiographs were made.

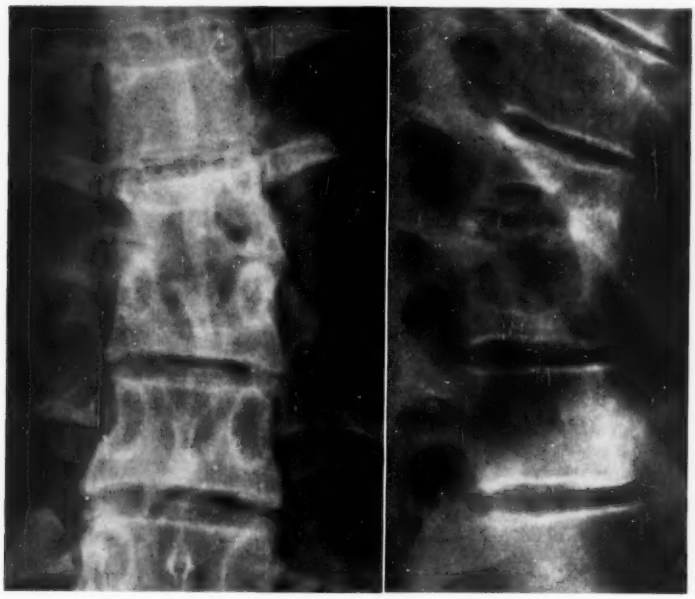

FIG. 3

Condition fourteen months after operation. Note sound healing without further collapse.

bone is the crucial factor. Cartilage in tuberculosis of the hip in childhood survives longer than bone (Phemister 1924). The author was impressed by the work of Swett (1923) and Pardee (1948) on synovectomy in the treatment of chronic arthritis. Key (1925) showed

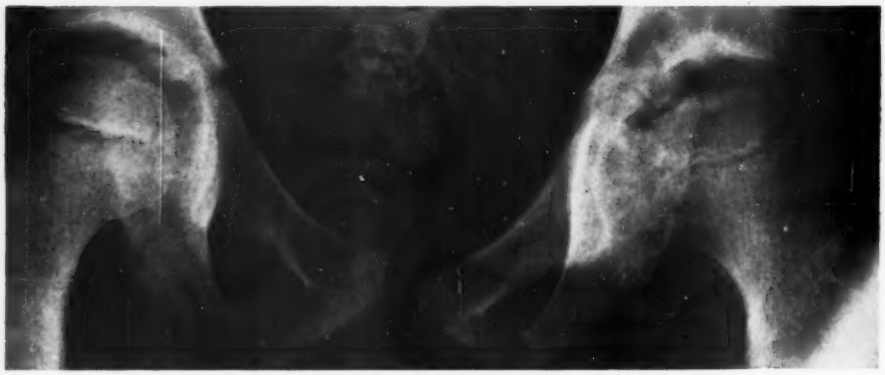

FIG. 4
Tuberculosis of the left hip. On admission.

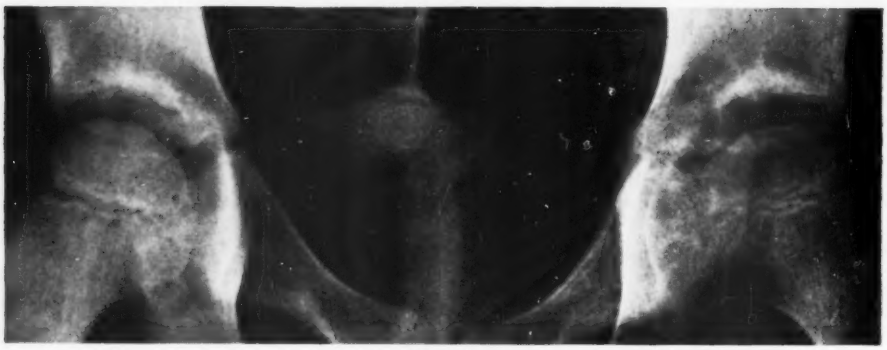

FIG. 5
Two months later, a month after synovectomy. Microscopy confirmed tuberculosis.

FIG. 6
A year later still, four months after discharge. There was a full range of movement.

experimentally in the rabbit that synovial membrane after removal was reformed in a few months. It seemed for these reasons that by partial capsulectomy and synovectomy tissues might be removed in which the circulation was defective; that after such operation

revascularisation might occur in reformed tissue kept healthy by streptomycin; and that the drug might then obtain access to the subchondral bone on which the integrity of the joint depended. A series of twenty-six children's hips have been operated upon with the loss so far of the function of only four joints. On the other hand the same treatment applied to four adult hips failed: the cartilage in the adults seemed too poor at the time of operation. The average duration of treatment of the successfully treated patients was 9·9 months. Illustrative radiographs are shown in Figures 4 to 6.

TUBERCULOSIS OF THE KNEE

Before antibiotics were introduced many children recovered from tuberculosis of the knee with a good range of movement (Mortens 1948). A small number of adults also recovered with useful range of movement but these, in the experience of the author, inevitably relapsed. Nevertheless the prognosis for recovery with function seemed more hopeful in tuberculosis of the knee than in tuberculosis of the hip. Partial synovectomy and capsulectomy as an adjuvant to treatment seemed therefore less necessary especially in children; it was felt that constitutional treatment and antibiotics might be sufficient to tip the balance in their favour. For adults, however, to ensure permanent recovery of function and to reduce the duration of treatment, it seemed desirable that every possible therapeutic device should be employed. The disadvantage of partial synovectomy in the treatment of tuberculosis of the knee is the impairment of movement after operation. Yet movement gradually returns and most patients in the author's series have regained movement up to 90 degrees. At operation no attempt is made to do a total synovectomy: only synovial membrane accessible from an anterior incision is removed. Of sixteen patients treated so far thirteen are well and have good function. The results are shown in Table V.

TABLE V

RESULTS OF TREATMENT OF TUBERCULOSIS OF THE KNEE BY PARTIAL SYNOVECTOMY

	Number of patients	Successes	Incomplete successes	Failures	Average duration of treatment (*months*)
Adults	11	9	1	1	7·6
Children	5	4	1	0	—

TUBERCULOSIS OF OTHER JOINTS

The same principles have been employed by the author for the treatment of other tuberculous joints, except the ankle, in which the results of erasion, and anterior fusion, have given in most patients stability and a useful limb. Partial capsulectomy and synovectomy has been used with success for the treatment of tuberculosis of the shoulder and the elbow when there has not been much joint destruction. The disease in the shoulder is usually associated with a tuberculous abscess cavity in the humeral head, visible radiographically, which should be curetted. Similarly an abscess cavity, visible radiographically, is usually present in the olecranon process in tuberculosis of the elbow: curettage of the cavity is then required.

MACROSCOPIC AND MICROSCOPIC CHANGES IN TUBERCULOUS TISSUES TREATED WITH STREPTOMYCIN

Operations on tuberculous tissues, after varying amounts of streptomycin treatment, have afforded an opportunity of assessing the drug by direct observation. In this paper chief emphasis will be placed on the macroscopic appearances: it is hoped that the microscopic study will in due course be published by a pathologist and for this reason detailed reference

to microscopic findings will be avoided here. It will, however, be necessary to note whether, as a result of microscopical examination, tuberculous changes could still be identified in the tissues treated by streptomycin. Reports are available on the macroscopic appearance of ninety-seven joints operated upon and on the microscopic appearances of sixty-six. Gross osseo-caseous tissues, such as those curetted from a granuloma of the vertebrae, were not always sent for examination. Some cases of arthrodesis of the hip and of femoral osteotomy

TABLE VI

PATIENTS OPERATED UPON AFTER NINETY DAYS' STREPTOMYCIN TREATMENT

Site	Number of patients operated upon	Marked disease	Moderate disease	Slight disease	Microscopy	
					Number of patients examined	Specific changes present
Spine						
Curettage	11	5	5	1	2	2
Knee						
Excision	2	2	—	—	2	2
Curettage	2	2	—	—	1	0
Synovectomy	12	3	6	3	11	6
Hip						
Osteotomy } Arthrodesis }	7	5	—	2	—	—
Synovectomy	12	2	4	6	11	8
Other joints	10	4	5	1	6	6
Tenosynovitis and bursitis	3	3	—	—	3	3
Total	59	26	20	13	36	27

TABLE VII

PATIENTS OPERATED UPON AFTER SIXTY TO NINETY DAYS' STREPTOMYCIN TREATMENT

Site	Number of patients operated upon	Marked disease	Moderate disease	Slight disease	Microscopy	
					Number of patients examined	Specific changes present
Spine	3	2	1	—	1	1
Hip	6	1	4	1	4	4
Knee	7	4	2	1	7	6
Other joints	2	2	—	—	2	2
Bursitis	1	—	1	—	1	1
Total	19	9	8	2	15	14

have been included in which the state of the tissues round the joint afforded information but tuberculous tissue was not removed. The macroscopic appearances have been analysed and are presented according to the site of the lesion and the duration of streptomycin treatment given before operation. Most patients operated upon showed gross inflammatory changes. In the Tables those classified as having marked disease usually presented even to the naked eye specific changes due to tuberculosis: those classified as having moderate

disease showed gross inflammatory changes but these could not always be identified as tuberculous by the naked eye: those classified as having slight changes showed only thickening with hyperaemia or fibrosis which could not be identified as tuberculous. The microscopic appearances also varied in intensity but the degrees of change are not discussed. Those patients included in the Tables who had no specific microscopic changes of tuberculosis after streptomycin treatment had other strong evidence of tuberculosis which justified their inclusion in the series. The first group to be considered will be those operated upon after ninety days of streptomycin treatment: the findings in these patients are shown in Table VI. Patients who had less than ninety days' pre-operative streptomycin treatment but more than sixty days' are analysed in Table VII. Patients who had less than sixty days' pre-operative streptomycin treatment but more than twenty days' are shown in Table VIII.

TABLE VIII

PATIENTS OPERATED UPON AFTER TWENTY TO SIXTY DAYS' STREPTOMYCIN TREATMENT

Site	Number of patients operated upon	Marked disease	Moderate disease	Slight disease	Microscopy	
					Number of patients examined	Specific changes present
Spine	1	—	1	—	—	—
Hip	9	6	1	2	8	7
Knee	5	2	3	—	4	4
Other joints	4	2	2	—	3	3
Total	19	10	7	2	15	14

Discussion—The following observations and conclusions are made from this part of the investigation.

1) The effects of streptomycin on tuberculous tissue are more marked after ninety days' treatment than after shorter periods of treatment. The tissues of thirty-six patients who had ninety days' treatment were examined microscopically, and twenty-seven showed changes specific for tuberculosis. The tissues of thirty patients who had streptomycin for less than ninety days were reported on: all but two showed specific changes. There was therefore a larger proportion of patients among those treated with ninety days' streptomycin who showed no specific changes than those who had less than ninety days. Yet it should also be remembered that many specimens in the ninety days' group were not sent for examination as they presented gross osseo-caseous lesions, thought not to be worth microscopy.

2) The tissues that showed the most marked changes after a full course of streptomycin were the synovial tissues. Twenty-two patients who had synovectomy of the hip or knee were reported on microscopically: fourteen showed specific changes: eight did not. Fourteen patients of the same ninety days' streptomycin-treated group who had operations into tuberculous granulomata or bone had microscopy of their tissues and all but one showed specific changes. The impression gained by the author at operation was that the effects of streptomycin on tuberculous bone or granulomata had been scanty: on synovial lesions more marked.

3) Even in those patients in whom specific changes had disappeared after ninety days' streptomycin treatment, gross inflammatory changes remained. These would no doubt still prejudice full natural healing. The operation of partial capsulectomy and synovectomy might therefore still improve the condition whether specific changes remained or not.

4) Certain patients who were operated upon late in treatment showed dense fibroid changes

in the synovial membrane, which was adherent, as a thickened sheet, to the periphery of the joint cartilages.

5) The gross inflammatory changes found at operation often belied the improved clinical appearance after streptomycin treatment. For example, seven patients are included who had osteotomy or arthrodesis of the hip after ninety days' streptomycin. Clinically these joints appeared fairly quiescent and had shown much improvement, but at operation hyperaemia of bone, oedema of surrounding tissues and abscess formation were found in five patients.

6) Most of the operations on hips and knees, included in Tables VII and VIII, of patients having less than ninety days' streptomycin, were partial capsulectomies and synovectomies. These operations were carried out on patients whose joints still showed activity, and the specific nature of the changes was easily confirmed macroscopically and microscopically.

To summarise the results of direct observation of tuberculous tissues treated by streptomycin, it can be said that in established osseous lesions the amount of improvement was not marked. This observation confirms the results of clinical comparison between patients treated with and without streptomycin for tuberculosis of the spine, described in the first part of this paper.

EFFECT ON SKELETAL TUBERCULOSIS OF ISO-NICOTINIC ACID HYDRAZIDE

It is only possible to write a brief note on a drug that has been available for only a few months. Twenty-two patients have been treated by the author, some of whom are still under treatment. Eight of these patients had combined courses of streptomycin and iso-nicotinic acid hydrazide: the remainder, courses of iso-nicotinic acid hydrazide alone. Seven patients had treatment for two months or more, and three for less than two months. Only the most salient features which can be discerned up to the present will be mentioned.

Four patients seemed to have made very good progress indeed; three of these had sinuses which have healed. The association of a healed sinus with good bone healing has been noted in other patients who have not had iso-nicotinic acid hydrazide. Nevertheless the combination of iso-nicotinic acid hydrazide and a draining sinus seems to have had a very favourable effect.

In two patients, both children, the tuberculous caries progressed in spite of full constitutional treatment and combined streptomycin and iso-nicotinic acid hydrazide. One had spinal, the other hip disease. Another patient, an adult, had slowly increasing tuberculosis of the spine while under treatment.

Seven patients were operated upon after courses of iso-nicotinic acid hydrazide. In all active disease was found at operation. The microscopical report on the synovial membrane of one patient, who had been treated with the drug seven weeks pre-operatively, was that abundant tuberculous granulation tissue was present.

The remaining patients made satisfactory progress under iso-nicotinic acid hydrazide but it is difficult to say to what extent the drug was responsible for their recovery.

These details, though scanty, have a similarity to the streptomycin findings and it is possible that a more extensive survey would lead to similar conclusions. It is said, however, that the molecule of iso-nicotinic acid hydrazide is smaller than that of streptomycin and that it is capable of better penetration of inflammatory tissues. The results, therefore, may prove better than those obtained by streptomycin. It does seem probable, however, from a consideration of the results so far obtained, that iso-nicotinic acid hydrazide will not cure established lesions without accessory treatment to remove the barriers caused by endarteritis. In this it resembles streptomycin.

SUMMARY AND CONCLUSIONS

Streptomycin and iso-nicotinic acid hydrazide are two powerful drugs lethal to tubercle bacilli, when access to the infected tissues is free. For early disease, before ischaemia and necrosis become established, they are curative: afterwards they are not. In this paper the

use of surgery to augment their action has been discussed. The development of such methods may well revolutionise the treatment of skeletal tuberculosis. Therein lies a danger because attempts to cure the patient by exterminating the tubercle bacilli in his lesion may lead to a precarious recovery: treatment directed against the bacilli may greatly facilitate a real cure if constitutional treatment is also applied to make the patient immune. Revolutionary though the change may become, it will not be so great as the revolution which occurred thirty years ago when open-air hospitals were first provided for patients with skeletal tuberculosis. The first patient ever seen on a surgical ward by the author, when he was a student, suffices still as an example. A child with tuberculosis of the cervical spine was admitted from out-patients with multiple discharging sinuses from the neck which was supported in a sodden plaster jacket. "Whoever," said the house surgeon dramatically, "removes that plaster, will kill that child." Most unfortunately his words were true. Many other such patients could, in those days, be seen in the wards of city hospitals. It was largely due to the work of Sir Robert Jones, friend of children, that the value of constitutional treatment became recognised. With the combination of the old knowledge and the development of the new, a new chapter in the treatment of skeletal tuberculosis has opened and rapid restoration of function and permanent cure can now take the place of long and sometimes crippling illness.

REFERENCES

ALLISON, N., and GHORMLEY, R. K. (1931): Diagnosis in Joint Disease. London: Humphrey Milford Oxford University Press.

BOSWORTH, D. M., WRIGHT, H. A., and FIELDING, J. W. (1952): The Treatment of Bone and Joint Tuberculosis; Effect of 1-Isonicotinyl-2-Isopropylhydrazine. Journal of Bone and Joint Surgery, **34–A,** 761.

BOYD, W. (1929): Surgical Pathology. Second edition, p. 853. Philadelphia: W. B. Saunders Company.

CAPENER, N. (1947): Personal Communication.

CLEVELAND, M., and BOSWORTH, D. M. (1942): The Pathology of Tuberculosis of the Spine. Journal of Bone and Joint Surgery, **24,** 527.

DAVIES, D. V. (1946): Synovial Membrane and Synovial Fluid of Joints. Lancet, **ii,** 815.

FEDERAL SECURITY AGENCY REPORT (1952): Public Health Service. Washington.

HARRIS, R. I., and COULTHARD, H. S. (1942): Prognosis in Bone and Joint Tuberculosis. Journal of Bone and Joint Surgery, **24,** 382.

JOINER, C. L., MACLEAN, K. S., PRITCHARD, E. K., ANDERSON, K., COLLARD, P., KING, M. B., and KNOX, R. (1952): Isoniazid in Pulmonary Tuberculosis. Lancet, **ii,** 843.

KEY, J. A. (1925): The Reformation of Synovial Membrane in the Knees of Rabbits after Synovectomy. Journal of Bone and Joint Surgery, **7,** 793.

MAJOR, R. H. (1939): Classic Descriptions of Disease. Second edition, p. 59. Springfield, Illinois: Charles C. Thomas, Publisher.

MEDICAL RESEARCH (1948): Streptomycin Treatment of Pulmonary Tuberculosis. British Medical Journal, **ii,** 769.

MEDLAR, E. M. (1949): The Pathology of Tuberculosis in Relation to Chemotherapy. *In* Streptomycin and Dihydrostreptomycin in Tuberculosis, p. 100. New York: National Tuberculosis Association.

MORTENS, J. (1948): Tuberculosis of the Knee Joint. London: H. K. Lewis & Co. Ltd.

PARDEE, M. L. (1948): Synovectomy of the Knee Joint. Journal of Bone and Joint Surgery, **30–A,** 908.

PHEMISTER, D. B. (1924): Changes in the Articular Surfaces in Tuberculous and in Pyogenic Infections of Joints. American Journal of Roentgenology and Radium Therapy, **12,** 1.

RIGGINS, H. McLeod, and HINSHAW, H. Corwin (1949): The Streptomycin-Tuberculosis Research Project of the American Trudeau Society. *In* Streptomycin and Dihydrostreptomycin in Tuberculosis, p. 33. New York: National Tuberculosis Association.

SITA LUMSDEN, E. G., and SWOBODA, J. A. F. (1952): Isoniazid in the Treatment of Pulmonary Tuberculosis. Tubercle, **33,** 322.

SWETT, P. P. (1923): Synovectomy in Chronic Infectious Arthritis. Journal of Bone and Joint Surgery, **5,** 110.

SWETT, P. P., BENNETT, G. E., and STREET, D. M. (1940): Pott's Disease: The Initial Lesion, the Relative Infrequency of Extension by Contiguity, the Nature and Type of Healing, the Role of the Abscess, and the Merits of Operative and Non-operative Treatment. Journal of Bone and Joint Surgery, **22,** 878.

WATSON-JONES, Sir R. (1949): Robert Jones Memorial Lecture. Journal of Bone and Joint Surgery, **31–B,** 137.

IDIOPATHIC SCOLIOSIS

The prognosis, diagnosis, and operative indications related to curve patterns and the age at onset

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The true understanding of any disease is based upon a knowledge of the etiology and natural history. In scoliosis we have little knowledge of the former; therefore the latter is of even greater significance to our comprehension and management of this still very obscure disease.

In 1950 Ponseti and Friedman presented a classification of idiopathic scoliosis based on the site and number of primary curves. Their conception is simple, and fundamental as a guide to prognosis. In this review the importance of Ponseti's views are confirmed. However, it will be seen that by considering not only the site of the primary curve but also the age at onset of the curve, an even greater accuracy in prognosis is possible. Each pattern of scoliosis has its characteristic age or ages of onset and, as would be expected, the earlier the onset the worse the final curvature. The age of onset is, however, subordinate to the site of the primary curve in the evolution of a curve.

Fig. 1

The iliac apophyses have reached the posterior superior spine. This indicates with reasonable certainty that an idiopathic curve will not increase.

Idiopathic scoliosis begins at all ages of childhood but there are three peak periods of onset—under the age of three, from five to eight, and from ten until the end of growth. For convenience I have called these age groups, infantile, juvenile and adolescent.

Two hundred and forty-one mature cases of idiopathic scoliosis whose curves will not now increase, and sixty-seven immature curves have been reviewed. A mature curve is one where spinal growth and curvature have ceased. Risser and Ferguson's (1936) observation that this coincides with completion of growth in the iliac apophyses round to the posterior superior spine has been confirmed (Fig. 1). The immature cases are discussed where relevant but not in statistics relating to the final curvature.

The severity of a curve has been based on radiographic criteria only. Although radiography gives us a true assessment of the amount of curvature, it does not indicate the

effect upon the child's appearance, for this varies greatly in each curve pattern, though the angle of curvature be the same. Radiographically, curves up to 69 degrees are classified as mild, those from 70 to 99 degrees as severe, and those greater than 100 degrees as very severe.

The types of idiopathic scoliosis, with the number of mature cases seen, are shown in Table I. A few in each series were not mature.

It will be seen that the percentage of each pattern in the two series varies considerably. One possible explanation is that Ponseti and Friedman recognised the primary curve

TABLE I

IDIOPATHIC SCOLIOSIS: CLASSIFICATION AND INCIDENCE BY TYPE

	Number of cases	
	Ponseti and Friedman	James
Lumbar	93	79
Thoraco-lumbar	63	26
Thoracic	87	Adolescent 66 Juvenile 16 Infantile 52
Combined lumbar and thoracic	146	69
Cervico-thoracic	5	0

essentially by radiological criteria, whereas in this series the clinical examination has been regarded as of greater importance. Fixed rotation on forward flexion has been interpreted as indicating a primary curve. In most cases the physical signs and the radiographic appearance lead to similar conclusions. It is in the differentiation of intermediate types that difficulty arises and this may explain the differences in the two series.

The essential feature of each pattern may now be briefly reviewed together with the degree of disability to be expected.

LUMBAR IDIOPATHIC SCOLIOSIS

Seventy-nine mature cases are reviewed. Except for one curve appearing at nine, the curvature invariably developed from ten years of age until the end of growth, the onset being equally scattered through these years of growth. The lumbar curve was unique in this onset during the years of adolescence.

There were seventy female patients and nine male. Unlike the other curves to be studied the proportion of right and left curves was almost equal. The apex of a lumbar curve was most commonly at Lumbar 1 but it was not rare at Lumbar 2 or 3. No significant difference in prognosis could be found in the variation of apex, site or length of this essentially homogeneous pattern. The degree of curvature found in this group at the end of growth confirms Ponseti and Friedman's view that it is benign (Fig. 2).

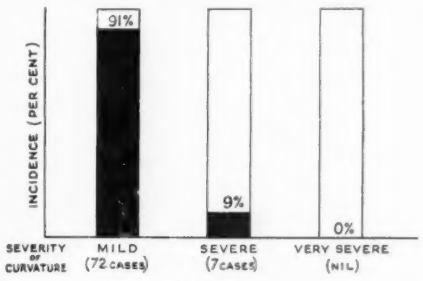

FIG. 2

Lumbar idiopathic scoliosis. The final curvature in seventy-nine mature patients.

It is in this group that the radiological criteria of severity are particularly harsh, for a " severe " curve of over 70 degrees is not in fact ugly. Even so, only seven patients, or 9 per

cent, had a curvature of over 70 degrees. The minimum final curvature was 12 degrees, the maximum 90 degrees (Fig. 3).

This curve pattern is benign not only because the degree of curvature remains small, but because no ribs are involved in the rotation, and the shoulders remain level.

Although it is, from the cosmetic point of view, an innocent curve, there is in later life one serious consequence—backache. In this series, thirty-nine patients were over twenty-five years of age and all had backache. Contrast this with thoracic scoliosis where only six patients amongst eighty-two complained of pain. The pain appears to arise in the posterior intervertebral joints, which probably become osteoarthritic because of their extreme rotation (Fig. 4).

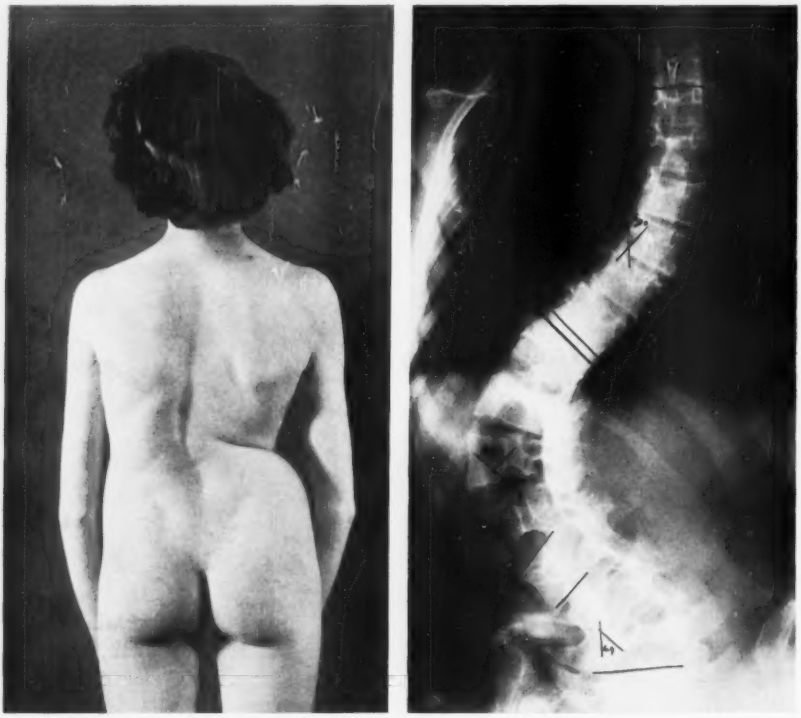

FIG. 3

Lumbar idiopathic scoliosis. A curvature of 90 degrees, the most severe lumbar curve in the series. Note that the appearance is not grossly affected.

THORACO-LUMBAR IDIOPATHIC SCOLIOSIS

This curve is not common: twenty-six cases only are available. The onset was in adolescence except for one at three and another at four years of age. Twenty of these twenty-six patients were girls and most curves were convex to the right. The apex always involved the eleventh or twelfth thoracic vertebra (Fig. 5).

As we review the patterns it will be found, in general, that the prognosis becomes worse as the site of the primary curve ascends in the vertebral column. The thoraco-lumbar curves are therefore intermediate between lumbar and thoracic curves in all characteristics. Some ribs are involved in the rotation, the shoulder sometimes drops, and on occasions the hip becomes extremely prominent, so that a slight curve may be very ugly. The incidence of

FIG. 4

A patient of sixty years with a 70-degrees curve. Her appearance is good. The radiograph shows osteoarthritis of the posterior joints, which caused severe pain.

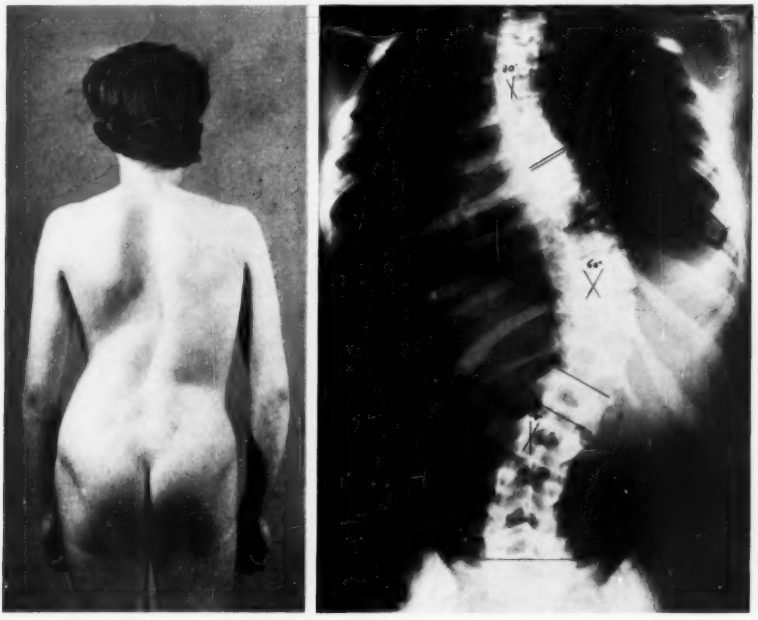

FIG. 5

Thoraco-lumbar idiopathic scoliosis. The photograph and radiograph of a patient with a 60-degrees curve in the thoraco-lumbar region, an average end-result.

severe cases was 31 per cent compared with 9 per cent in the lumbar group (Figs. 6 and 7). Only two of this group have required correction and fusion.

As might be predicted with a curve which is half within the lumbar area, eight adults of the nine complained of pain.

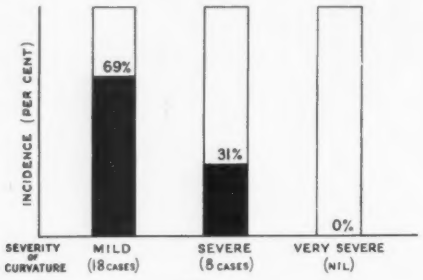

FIG. 6

Thoraco-lumbar idiopathic scoliosis. The final curvature in twenty-six mature patients.

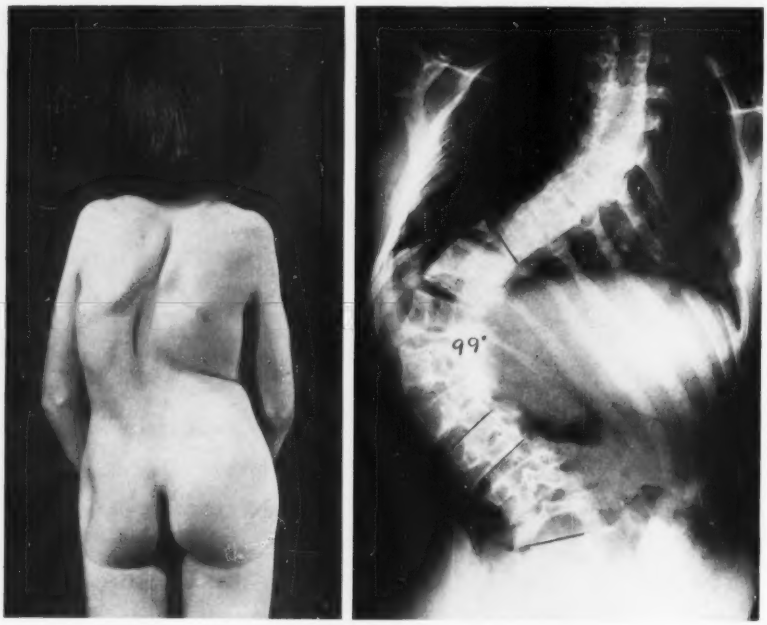

FIG. 7

Thoraco-lumbar idiopathic scoliosis. The greatest thoraco-lumbar curve in the series. 99 degrees.

THORACIC IDIOPATHIC SCOLIOSIS

This large group can be usefully subdivided according to the age of onset: of the 134 mature curves sixty-six began in adolescence, sixteen were classified as juvenile and fifty-two as infantile. In this last subdivision not all the patients were fully grown. Thus it can be seen that the thoracic curve is common: it is also the most important.

It is in thoracic scoliosis that consideration of the age at onset is most important. In many patients thoracic scoliosis commences early, and the earlier it begins, the worse the prognosis (Fig. 8).

Thoracic scoliosis in infants is more common in boys and is to the left in 92 per cent; in adolescence it is to the right in 90 per cent and nearly always affects girls (Figs. 9 and 10). These and other differences have suggested a subdivision of thoracic scoliosis into three groups based on the age of onset. These will now be considered separately.

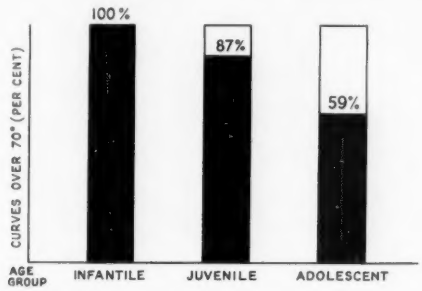

FIG. 8
Thoracic scoliosis. Percentage of curves greater than 70 degrees related to the age of onset.

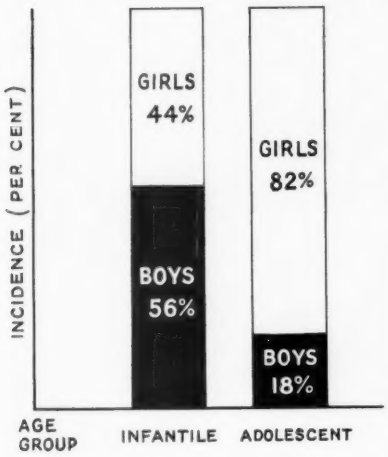

FIG. 9

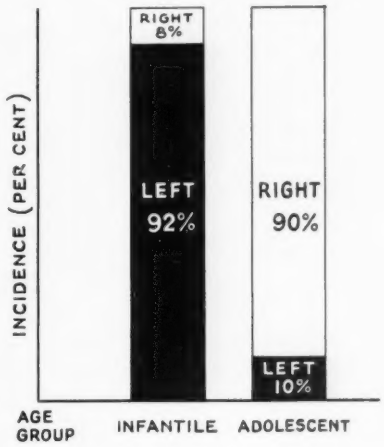

FIG. 10

Figure 9—Sex incidence in infantile and adolescent thoracic scoliosis. Figure 10—Convexity of curve in infantile and adolescent thoracic scoliosis.

The site of the apex from Thoracic 6–10 and the number of vertebrae in the curve did not differ materially between these groups.

Adolescent thoracic idiopathic scoliosis—Sixty-six mature cases were examined. The age of onset was from ten years onwards. The prognosis did not vary whether the onset was in early or late adolescence: the average age of the patients with mild curves at onset was 12·1 years, and of those with very severe curves 12·3 years.

There were fifty-four girls amongst these sixty-six patients. Sixty of the curves were convex to the right, and it is remarkable that only two girls had a curvature to the left, whereas four of the twelve boys had left curves.

The prognosis is unfavourable because, beyond all others, this pattern of curve tends to increase to a gross degree. The percentage of severe or very severe curves was 59 per cent. The smallest mature curve was 24 degrees, the worst 151 degrees (Fig. 11).

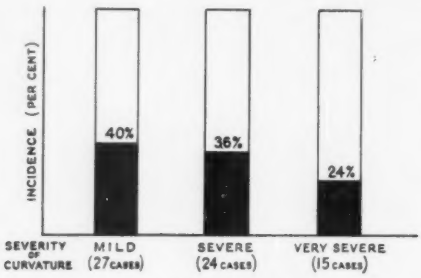

FIG. 11

Adolescent thoracic idiopathic scoliosis. The final curvature in sixty-six mature patients.

In thoracic scoliosis the deformity is made worse by rotation of ribs, dropping of the shoulder, and prominence of the hip. In this group the radiological grading does not sufficiently stress the ugliness of the curve (Figs. 12 to 14).

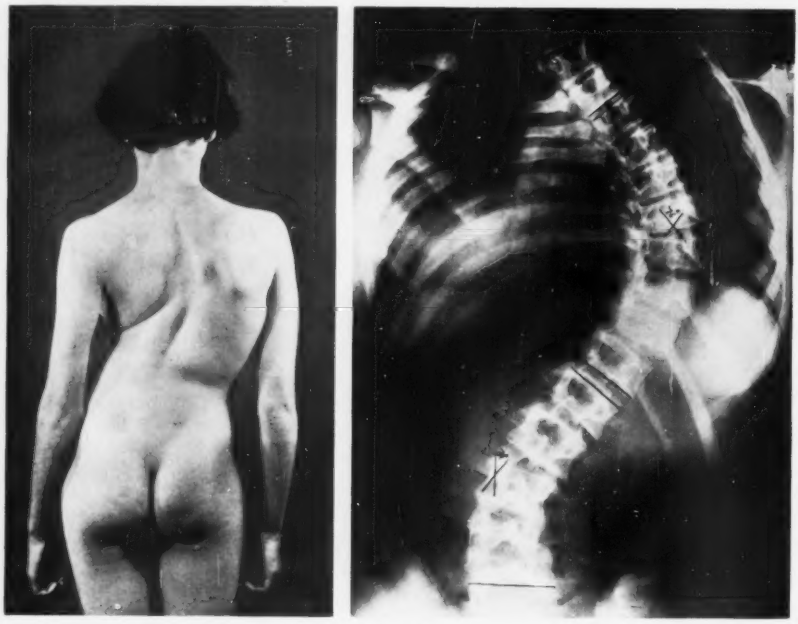

FIG. 12

Adolescent right thoracic scoliosis of 76 degrees. These curves often need operative correction at 70 degrees but there is considerable individual variation in appearance.

Nineteen corrections and fusions were undertaken in this group, because of either existing or expected deformity. Many curves were incorrectable when first seen.

Juvenile thoracic idiopathic scoliosis—This small group of sixteen with an onset between the fifth and eighth years is possibly not worthy of separation from the preceding group:

FIG. 13

FIG. 14

Adolescent right thoracic scoliosis. At the age of thirteen the curve was 51 degrees (Fig. 13). Three years later the curve had increased to 151 degrees (Fig. 14).

FIG. 15

Infantile thoracic idiopathic scoliosis. A girl of four and three-quarter years with a curvature of 87 degrees. A year later it was 116 degrees.

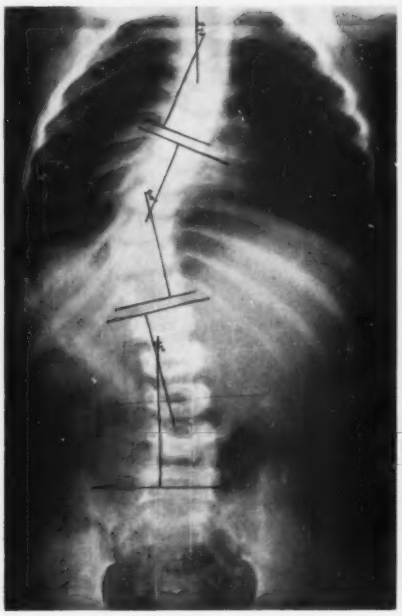

FIG. 16

FIG. 17

Infantile thoracic idiopathic scoliosis. At the age of one and a half years the curvature was of 40 degrees (Fig. 16). At the age of twelve years it had increased to 136 degrees (Fig. 17).

FIG. 18

Combined lumbar and thoracic scoliosis. A combined curve, each primary being of 66 degrees.

further observation will clarify this detail. Nevertheless the prognosis does seem significantly worse. Fifteen of these sixteen patients were girls; all but two of the curves were right.

There was a majority of severe curves (87 per cent), as might be expected of a curve progressing during many years of active growth. The two mild curves were only classified so by a margin of a few degrees. Of this small group nine have been corrected and fused and three were inoperable.

Infantile idiopathic thoracic scoliosis—Fifty-two cases will be discussed, but nine of these must be considered separately because their curves disappeared spontaneously. Of the remaining forty-three patients only a proportion are fully grown. Adults attending with a history of onset in infancy have been excluded unless an early radiograph showed no bony congenital abnormality, because adult radiographs are so confused by secondary changes that the exact etiology cannot always be established. In all cases the onset has been before three years of age and was most common from the sixth to eighteenth month of life. Boys predominate and left curves have a near monopoly.

TABLE II

INFANTILE IDIOPATHIC THORACIC SCOLIOSIS: SEVERITY OF CURVE RELATED TO PRESENT AGE

Curvature	Number of patients	Average present age
0°–69°	21	4·8 years
70°–99°	12	8·2 years
over 100°	10	12·3 years

These and other features so separate them from the other thoracic scolioses as to leave small doubt that this is a distinct pattern. There is much evidence to suggest that it is in no way different from the idiopathic scoliosis of later years. No previous suggestion has been found in the literature that an infantile group of idiopathic scoliosis exists but exclusion of all cases with visible bony abnormality leaves this remarkably homogeneous group.

Although many curves are immature, comparison of the average age in children who have at present mild, severe or very severe curves is instructive (Table II).

This analysis suggests that only the very young have mild curves. No child over the age of ten years has escaped a curve of 70 degrees or more, nine children under ten have curves of over 70 degrees and several of these have curves over 100 degrees. It seems likely that in every case the prognosis is serious, and severe crippling, with a curve of over 70 degrees and often over 100 degrees, must be expected. There are now few orthopaedic conditions able to produce so hideous a deformity as this pattern of scoliosis (Figs. 15 to 17).

As already mentioned, there are still to be considered nine cases, all in patients under two years, with curves of less than 20 degrees with radiological and sometimes clinical rotation. In all, the curves disappeared spontaneously by two years of age. I am not fully persuaded that they were all structural curves, although some had a fixed rotation.

CERVICO-THORACIC IDIOPATHIC SCOLIOSIS

Ponseti described five such cases with a good prognosis. No cases have been seen in this series.

COMBINED LUMBAR AND THORACIC IDIOPATHIC SCOLIOSIS

Until now we have reviewed scolioses with three curves, the middle one of which is the primary. This last pattern has four curves, the middle two being primary. It combines characteristics of both lumbar and thoracic curves but the development of the thoracic element seems to be held in check. The shoulders remain level, the hips covered, and with a

posterior rotation on the left and right the back looks flat. The patient looks much better than the radiograph would suggest. The two primary curves generally keep in step (Fig. 18).

Fifty-four mature cases were seen. The majority of combined curves started in adolescence. This pattern, which does occasionally commence in infancy, is the most frequent curve arising in the juvenile group. In addition to the fifty-four mature cases whose prognosis is reviewed, there were additional patients, still immature. Altogether nine combined curves started in infancy, but it is much less common than the infantile thoracic curve already discussed. Seventeen curves started between the fifth and eighth years and it is the characteristic curve of the juvenile group. Amongst the nine infantile curves were three males and six left thoracic curves.

The adolescent group consisted largely of girls with right thoracic primary curves. The

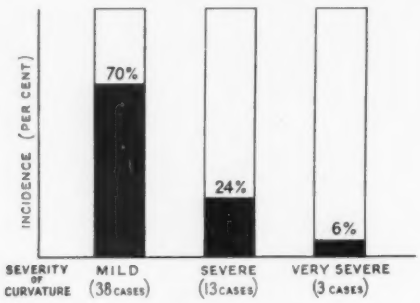

FIG. 19

Combined lumbar and thoracic scoliosis. The final curvature in fifty-four mature patients.

apex of the thoracic curve lay between the sixth and eighth thoracic vertebrae and the lower curve at the second lumbar.

The prognosis is good, only 31 per cent being classified as severe or very severe. The three very severe curves of over 100 degrees all started in the juvenile group but there were twelve severe cases in the adolescent group (Fig. 19). Because of the small cosmetic effect no patient has so far been advised to have correction and fusion (Figs. 20 to 22).

DISCUSSION

It is instructive to compare the prognosis and appearance of the four major patterns that have been described (Figs. 23 and 24).

There is no evidence that any form of conservative treatment influences the prognosis; indeed most of the mild curves received no treatment, whereas the severe curves have all received vigorous and varied conservative therapy over many years.

It is realised that the material drawn from a special clinic is selected, with an undue proportion of serious cases referred. This is unlikely to have affected the comparison between the various patterns.

Diagnosis—Idiopathic scoliosis is a three-curve arrangement, or four. In the former case the middle one of the three is primary, in the latter the middle two of four. The primary curves retain rotation on forward flexion, whereas the compensatory curves do not except to a minor degree in some long standing cases. Clinical examination is better than radiography to determine which is the primary curve and rotation is the significant sign in establishing the curve pattern. Occasional intermediate patterns with minimal rotation in the lumbar region offer difficulty in diagnosis between the three- and four-curve patterns.

Indications for operation—The lumbar and perhaps the combined thoracic and lumbar scolioses never need correction, although fusion may be indicated for pain.

FIG. 20

FIG. 21

Combined lumbar and thoracic idiopathic scoliosis in a girl. At the age of eleven the primary curvature was 37 degrees and 30 degrees (Fig. 20). Four years later it was 101 degrees and 112 degrees (Fig. 21).

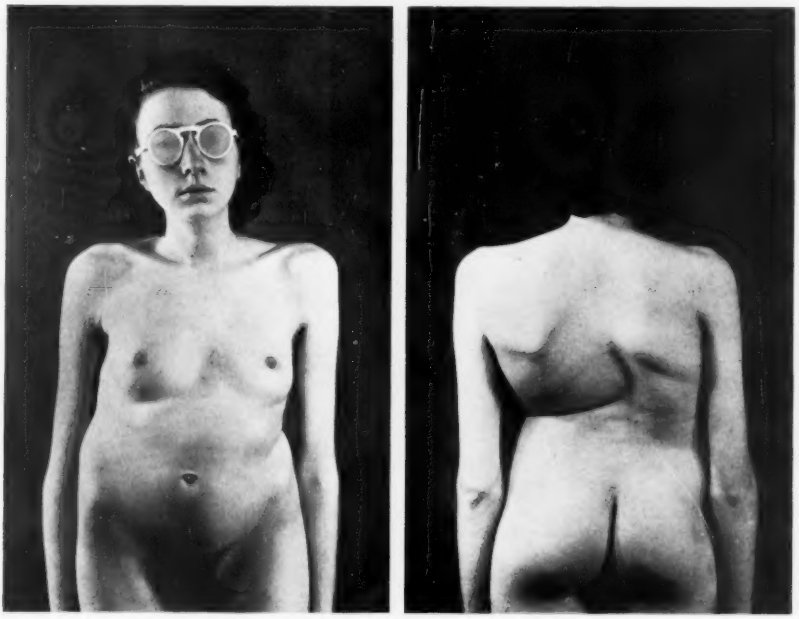

FIG. 22

Same patient. Photograph to show clinical appearance of curve at age fifteen.

Thoraco-lumbar curves rarely require correction and fusion, and so good is the general prognosis that it is better to await the development of deformity, although a prominent hip may be most conspicuous even when the curve is small.

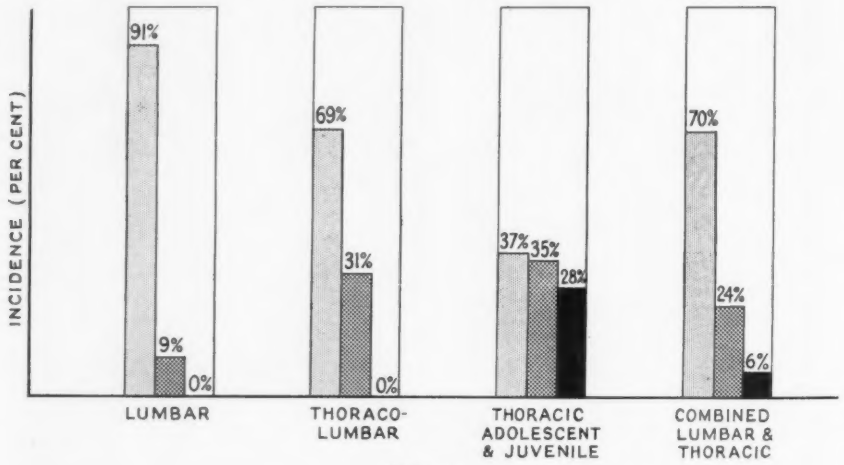

FIG. 23

Prognosis according to pattern of curve. Incidence of mild, severe and very severe curves in each of the four major curve patterns. Mild curves are represented by light shading, severe curves by dark shading, and very severe curves in black. Compare with Figure 24.

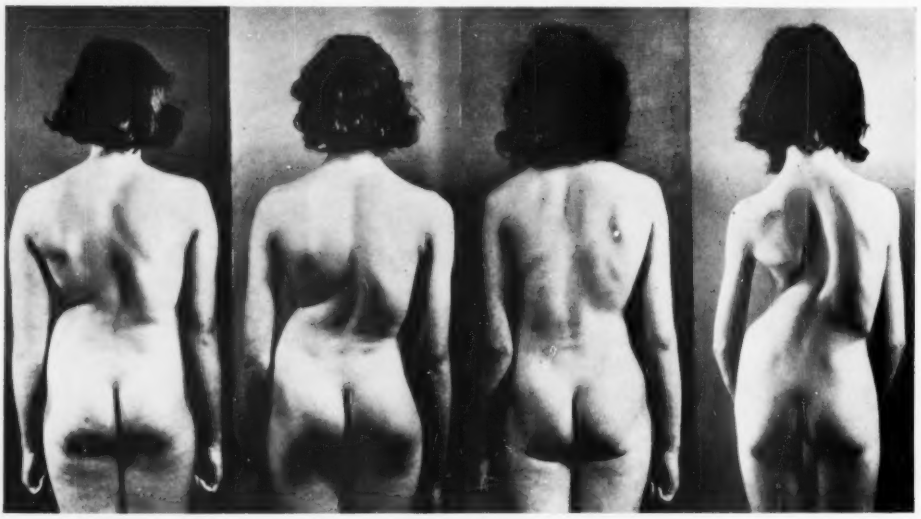

FIG. 24

Photographs of four patients each with the same degree of curvature (70 degrees) but each with a different curve pattern. From left to right the curves are lumbar, thoraco-lumbar, combined thoracic and lumbar, and thoracic.

In thoracic scoliosis the situation is different. When the onset is in adolescence perhaps half of all patients may be expected to develop a severe curve; with a curve of juvenile onset the proportion is over 80 per cent, and with an infantile over 90 per cent.

Severe scoliosis is not in itself an invariable indication for radical treatment, but a curve with a bad prognosis in degree of curvature and appearance obviously demands surgery.

If the curve pattern and age of onset are considered together, accurate prognosis is possible. Correction and fusion may then be confidently advised for the *prevention* of future deformity. Correction of well established curves is difficult and the rib rotation remains. In young patients, before deformity is serious, correction is relatively easy and more complete, but I have hesitated so far to operate before the age of ten years. If spinal fusion in adolescence proves satisfactory, it may be possible to intervene at an earlier age.

SUMMARY

The evolution of an idiopathic scoliosis is determined by the site of the primary curve and by the age of onset. It is significant that thoracic primary curves are commonly severe and the early onset of this curve accentuates this feature. Early operation based on prognosis is practised but sufficient time has not yet elapsed to justify any conclusions.

I should like to thank the many surgeons who have referred cases. I would especially thank Mr T. L. Carr and Mr M. Singer who spent many hours checking the curve measurements with me.

REFERENCES

American Orthopaedic Association, Research Committee of the (1941): End-result Study of the Treatment of Idiopathic Scoliosis. Journal of Bone and Joint Surgery, **23,** 963.

Goff, C. W. (1938): Scoliosis in Young Infants. (Abstract of a number of articles written by R. J. Harrenstein.) Journal of Bone and Joint Surgery, **20,** 1,070.

Harrenstein, R. J. (1936): Sur la Scoliose des Nourrissons et des Jeunes Enfants. Revue d'Orthopédie, **23,** 289.

James, J. I. P. (1951): Two Curve Patterns in Idiopathic Structural Scoliosis. Journal of Bone and Joint Surgery, **33–B,** 399.

James, J. I. P. (1952): The Management of Scoliosis. Postgraduate Medical Journal, **28,** 386.

Lovett, R. W. (1912): Lateral Curvature of the Spine and Round Shoulders. Second edition. London: Rebman Limited.

Osmond-Clarke, H. (1950): Scoliosis. *In* Modern Trends in Orthopaedics, 220. Edited by Sir Harry Platt. London: Butterworth & Co. (Publishers) Ltd.

Ponseti, I. V., and Friedman, B. (1950): Prognosis in Idiopathic Scoliosis. Journal of Bone and Joint Surgery, **32–A,** 381.

Risser, J. C., and Ferguson, A. B. (1936): Scoliosis: its Prognosis. Journal of Bone and Joint Surgery, **18,** 667.

Schulthess, W. (1905–07): Die Pathologie und Therapie der Rückgratsverkrümmungen. *In* Handbuch der Orthopädischen Chirurgie. Band 1, Abt. 2, 487. Ed. Joachimsthal. Jena: Gustav Fischer.

Steindler, A. (1950): Nature and Course of Idiopathic Scoliosis. American Academy of Orthopaedic Surgeons Instructional Course Lectures, **7,** 150.

RADIOGRAPHIC BONE CHANGES AT THE HIP AFTER INSERTION OF AN ACRYLIC PROSTHESIS

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The object of this paper is to report the changes that take place in the upper end of the femur after the insertion of an unplasticised acrylic prosthesis. The operation of femoral head replacement (Judet and Judet 1952) is practised so frequently that it is important to have knowledge of its effect on surrounding tissues. As the prosthesis is transradiant, bone changes and their variations can be observed in post-operative radiographs and arthrograms.

CLINICAL MATERIAL

Forty-four patients have been reviewed, out of a consecutive series of fifty-six patients operated upon between May 1950 and April 1952. Of the remainder, three patients are dead (one as a result of the operation), five are untraced and four are excluded because of complications, some of which have been described in a recent paper (Buxton and Waugh 1953). The average follow-up period was twenty months (longest thirty-two months, shortest twelve months). The primary condition was osteoarthritis in twenty-nine patients, subcapital fracture in eight, avascular necrosis in five, rheumatoid arthritis in one and congenital dislocation in one.

MECHANICAL CONSIDERATIONS IN REPLACEMENT ARTHROPLASTY

The possible forces acting on the prosthesis will vary with the angle of insertion, the weight of the patient and the amount of walking and weight bearing. The consequent changes will also depend on the quality of the underlying bone. Generalisations made from purely mechanical premises may, therefore, be unreliable when applied to a particular patient. It is nevertheless fundamental to point out the differences that arise in valgus and varus positions of the prosthesis. When the prosthesis is in valgus most of the force is transmitted directly downwards on the whole rim of bone which forms the stump of the neck and on the lateral cortex of the femur which is in contact with the end of the stem (Fig. 1). When the prosthesis is in varus the proximal part of the stem of the prosthesis is pressed against the lower rim of the neck, which becomes a broad fulcrum, and there is a corresponding upward thrust at the distal end (Fig. 2). The distal half-inch of the stem is a typical site for fracture of the plastic, a fact which confirms the presence of stress at this point. Because of the many possible variations any particular hip will usually show a combination of changes which are the result of forces between these extremes. In most cases of this series the prosthesis was inserted with the stem parallel to the lower border of the neck, which corresponds to an angle of about 15 degrees of valgus to the central axis of the neck.

Further operative details should be mentioned. First, the end of the stem of the prosthesis was inserted down to, but never through, the cortex of the femur. Second, after removal of soft tissue no attempt was made to ream the acetabulum extensively except when it was shallow (as in old congenital dislocation).

RADIOGRAPHIC CHANGES AFTER REPLACEMENT ARTHROPLASTY

The upper end of the femur. *The bony channel in the femoral neck*—The first change seen after the operation is the development of a linear shadow which appears to outline the transradiant stem of the prosthesis. This consists of a condensation of bone trabeculae

which may represent a healing reaction in the raw surfaces left by the reamer. In standard films in which the magnification is slight and when the diameter of the metal insert is known, measurements can be made which allow the width of the radiotranslucent plastic to be compared with the width of the bony channel. This was done in thirty-three cases. The

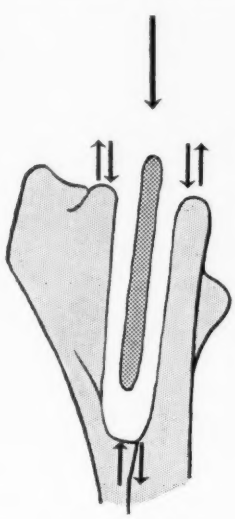

FIG. 1

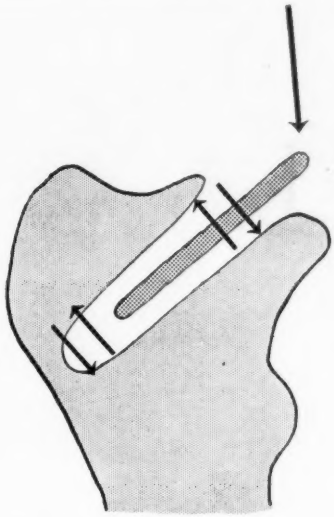

FIG. 2

Figure 1—Tracings from a radiograph showing the hypothetical forces acting on the stump of the neck and lateral cortex when the prosthesis is inserted in valgus. Note the even development of the upper and lower borders of the neck and the ledge which forms to support the lower end of the stem. Figure 2—Tracings from a radiograph showing the hypothetical forces acting when the prosthesis is inserted in varus. Note buttressing of the lower border of the neck which acts as a fulcrum, and the upward thrust at the lower end of the stem.

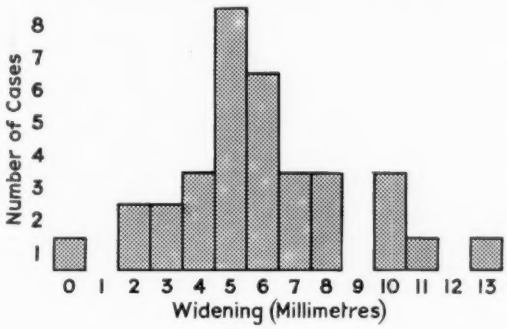

FIG. 3

Incidence and degree of widening of the bony channel in thirty-three hips. This is measured by subtracting the width of the prosthesis (after magnification) from the width of the bony channel opposite the midpoint of the metal insert.

results are given in Figure 3: they show that in most cases the prosthesis is lying in a bony channel several millimetres wider than itself. In order to investigate this point further a series of arthrograms was done and these showed that the contrast medium frequently trickles down inside the femur around the stem (Fig. 4). The width of the film of contrast

FIG. 4

Case 1—Man of sixty-one. Pre-operative diagnosis: osteoarthritis. Arthrogram two and a half years after operation, showing contrast medium running into the channel around the stem of the prosthesis.

medium does not correspond exactly with the space between the stem and the wall of the bony channel. A clear zone is sometimes apparent between the bone and the opaque material, suggesting that the bony channel is lined with a layer of soft tissue (up to two millimetres thick). Therefore, although the prosthesis is loose, direct comparison between the width of the stem and the diameter of the bony channel gives an exaggerated impression of its looseness. It might be inferred that in these conditions the prosthesis would be pressed towards the lower border of the neck when weight was taken through the hip. This does in fact occur, for the metal insert comes to lie nearer the lower border of the bony channel than the upper. The alteration of angle is so slight that it cannot be easily determined, but the actual shift at the mid-point of the insert can be measured. Figure 5 shows the amount of displacement in the thirty-three hips. In three, which appear separate from the rest, the movement was considerable. Figures 6 and 7 illustrate this deflection of the prosthesis. Radiographs of the hip in adduction (Fig. 6) and in abduction (Fig. 7) provided no evidence that the prosthesis was able to rock within its apparently wide channel; it seems likely, therefore, that the space between the upper part of the stem and the bony channel is largely filled with soft tissue. In this case the inclination towards varus was observed within a year of operation, but thereafter it did not increase.

In the three cases in which displacement of the prosthesis occurred the operation had been undertaken for recent subcapital fracture. At operation the femoral neck consisted of a thin outer shell of cortex with little compact bone. This, together with a deficiency of cancellous tissue, favours angulation of the prosthesis. In cases of osteoarthritis, in which the bone of the neck provides more adequate support, angulation is slight and there is no reason to suppose that it is detrimental to the functional result, despite undoubted loosening of the prosthesis.

The stump of the neck—In most cases the cut edge of bone becomes smooth and rounded during the first year after the operation, thus conforming to the under-surface of the head of the prosthesis. When the prosthesis is in valgus the upper and

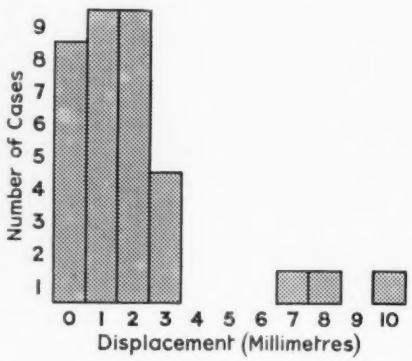

FIG. 5

Displacement of the prosthesis towards the lower border of the neck in thirty-three hips. The displacement is measured by subtracting the distance between the lower border of the insert and the lower border of the bony channel from the distance between the upper border of the insert and the upper border of the bony channel. These measurements are made opposite the midpoint of the insert.

FIG. 6

FIG. 7

Case 2—Woman of fifty-six. Pre-operative diagnosis: recent subcapital fracture. Radiographs two years after insertion of a prosthesis. Note widening of the bony channel and displacement of the prosthesis towards the lower border of the neck. There is no alteration in the relationship of the stem to the bony channel when the hip is adducted (Fig. 6) and abducted (Fig. 7).

FIG. 8

FIG. 9

Case 3. Figure 8—Woman of forty-four. Pre-operative diagnosis: osteoarthritis. Radiograph two and a half years after operation. Note the rounding off and equal development of the upper and lower borders of the neck which is associated with the valgus insertion of the prosthesis. There is slight subluxation, with sclerosis and erosion in the roof of the acetabulum. There is a well developed cortical ledge supporting the end of the stem. Case 4. Figure 9—Woman of seventy. Pre-operative diagnosis: avascular necrosis complicating subcapital fracture treated by Smith-Petersen nail. Radiograph one year and three months after operation shows well developed buttressing of the lower border of the neck.

lower borders of the neck appear equally well developed (Figs. 8 and 10). If the prosthesis has been placed in the neutral or varus position, there is usually sclerosis and sometimes obvious buttressing of the lower border (Fig. 9). In three cases a rim of bone was present around the collar of the head and this has been found to be associated with small fragments of new bone in the capsule (Fig. 10). In five cases the lower border of the neck was deficient (Fig. 11): in four of these the operation was for recent subcapital fracture. It is, therefore, likely that the defect is due to damage at the time of injury (or later during operation). In these circumstances it is possible that a great part of the weight-bearing thrust is taken on the upper border of the neck through the collar of the prosthesis. This is undesirable because the collar is thin and liable to fracture.

FIG. 10

FIG. 11

Case 5. Figure 10—Woman of fifty-one. Pre-operative diagnosis: osteoarthritis. Radiograph two years after operation showing a rim of bone that has developed around the skirt of the prosthesis. Some fragments of new bone are present. Note the ledge supporting the lower end of the prosthesis and the bulge in the lateral cortex. Case 6. Figure 11—Man of seventy-three. Pre-operative diagnosis: recent subcapital fracture. Radiograph two years after operation showing the deficient lower border of the neck.

The distal end—When the prosthesis reaches, but does not penetrate, the lateral cortex of the femur below the trochanter obvious alterations in the normal bony structure take place. These are seen as early as six months after operation and are the consequence of weight bearing. First, there is condensation of trabeculae below and around the end of the stem, forming a triangle or ledge of bone which undoubtedly helps to support the prosthesis. Secondly, subperiosteal new bone is frequently laid down on the lateral cortex opposite the end of the stem. These two reactions are frequently present, either separately or together, depending on the angle of insertion of the prosthesis. They are illustrated in Figures 8 and 10.

Changes in the acetabulum—Radiographic changes develop only occasionally in the acetabulum. They are usually associated with a tendency to subluxation, when the weight-bearing surface is concentrated over a relatively small area. Here sclerosis and sometimes erosion are produced which were not present before operation (Fig. 8). When subluxation has occurred the unoccupied part of the acetabulum becomes filled (presumably with fibrous

tissue), as shown by arthrograms (Fig. 12). Radiographs taken in the extremes of abduction and adduction demonstrate that the movement is concentric in this range.

New bone formation—The formation of bone in the soft tissues around the hip may occur after any form of arthroplasty. Only twice in this series has it been accounted the cause of pain and limited movement. In six patients small fragments of bone were present (Fig. 10), but they have not interfered with function.

DISCUSSION

Some details of the technique of the operation are controversial and these will be examined in the light of the experience gained from this review.

It has been stated already that in most cases the stem of the prosthesis was inserted at an angle of about 15 degrees to the central axis of the neck. If the angle is more valgus, subluxation (with a tendency to pain or dislocation) will result. If the angle is varus the possibility of fracture is increased because more strain is taken directly across the stem. At operation it is not always easy to assess the angle correctly. Moreover measurement on post-operative radiographs is liable to misinterpretation because slight variations in rotation will alter the apparent relationship of head to neck. Although it is of no real value to be over-precise about the desired angle, the theoretical aim should be to insert the prosthesis so that the reconstruction approaches the normal anatomy as nearly as possible. In judging this it is best to err slightly on the side of valgus because this gives a good seating of the prosthesis and, provided the angle is not more than 15 degrees, a satisfactory result can be expected.

FIG. 12

Case 7—Woman of sixty-six. Pre-operative diagnosis: recent subcapital fracture. Arthrogram one year and three months after operation showing lateral subluxation associated with a short and poorly developed femoral neck. Weight is transmitted through a small area of the roof of the acetabulum, where the bone is sclerotic. The apparently empty part of the acetabulum has not filled with contrast medium and may, therefore, be occupied by soft tissue.

As far as has been ascertained, most surgeons follow Judet's practice of attempting to anchor the prosthesis by driving the end of the stem through the lateral cortex of the femur. This technique was not followed in this series; so it has not been possible to study the bone changes that take place in those circumstances. From a mechanical point of view penetration of the cortex should give a more satisfactory distribution of forces and better fixation of the prosthesis; but it is difficult to see how loosening can be prevented, for with present techniques and materials there is no way of achieving permanent union between plastic and bone. If the length of the prosthesis is calculated accurately so that its end reaches down to the cortex, the bone reaction round it will afford adequate support and stability. In no instance has it been possible to localise pain exactly to this area of cortical sclerosis.

The study of the radiographic appearances after replacement arthroplasty helps to clarify some of the doubts that have arisen about the reaction of bone to pressure from an inert material. In no case in this series, for example, has the neck shortened to any appreciable

extent. Its lower border, on which a great part of the stress is taken, often shows sclerosis and sometimes buttressing. Some degree of loosening appears to be inevitable; but displacement of the prosthesis towards the lower border of the neck is slight and does not appear to be progressive. In fact, the radiographic appearance suggests that the prosthesis becomes stabilised after about a year and a half, and there is no obvious reason why deterioration should occur. Wolff's law, which states that " the organism produces new forms and new structures which are once more in harmonius relationship with the new conditions " may possibly be true when the new conditions are produced by the insertion of an acrylic prosthesis. Certainly a favourable bone reaction, which helps to produce stability, does occur where the end of the stem reaches the femoral cortex, and probably also in the lower border of the neck. Time alone will show whether bone will atrophy under pressure which is continued intermittently over five or ten years, but the impression gained from this review is that it is unlikely to do so.

This paper has been largely concerned with the radiographic appearances. It is, of course, realised that a hip that appears mechanically satisfactory may have poor function. Nevertheless, that is no argument against our making the reconstructed joint as perfect as possible anatomically. It has already been stressed that too much varus increases the stress on the prosthesis and the liability to fracture, and that too much valgus entails a risk of subluxation and a painful hip. When the bone of the neck is osteoporotic and fails to provide adequate support (as in some cases of recent subcapital fracture and when there are advanced cystic changes in osteoarthritis) the prosthesis may angulate towards the varus position in the neck, with consequent impairment of function. The causes of success or failure are, however, not always easy to find and they may well lie partly in the soft tissues around the joint or in the patient's mental reaction to the new conditions created by the operation.

SUMMARY

1. Radiographic changes in bone structure which follow the insertion of an unplasticised acrylic prosthesis of the Judet type are described.

2. Technical details of the operation and their relation to these changes are discussed.

3. Although the period of observation is short it is suggested that after initial loosening the prosthesis becomes stabilised owing to local bone reaction.

Our thanks are due to Mr H. L.-C. Wood and other members of the staff of the orthopaedic department of King's College Hospital for their co-operation in the study of all aspects of arthroplasty of the hip. Discussion with Dr J. T. Scales and Dr J. M. Zarek has been helpful in the study of the changes produced by plastic materials in the body. We also wish to thank Mr Guy Drew for his personal interest in the development of the prostheses that have been used.

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REFERENCES

BUXTON, St J. D., and WAUGH, W. (1953): Complications and Difficulties of the Judet Arthroplasty. Journal of Bone and Joint Surgery, **35-B**, 57.

JUDET, R., and JUDET, J. (1952): Technique and Results with the Acrylic Femoral Head Prosthesis. Journal of Bone and Joint Surgery, **34-B**, 173.

HYPEREXTENSION INJURY OF THE NECK WITH PARAPLEGIA

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An example of paraplegia due to hyperextension of the neck is described in which neurological and post-mortem examination demonstrated the nature and mechanism of the injury.

CASE REPORT

A man of sixty-three years, suffering from influenza, fainted and struck his forehead on a wall. When he regained consciousness about a minute later, he could not move his limbs and had paraesthesiae and numbness of the extremities. He was known to have had pain

Fig. 1

Fig. 2

Figure 1—Abrasions caused by the fall forwards on to the forehead. Figure 2—Post-mortem photograph of cervical spine *in situ*, showing rupture of anterior longitudinal ligament.

and stiffness of his neck for four years. Examination the day after injury showed abrasions of the forehead (Fig. 1). The heart and lungs were normal and the blood pressure was 135/85 millimetres Hg. The cranial nerves and optic discs were normal and there was no sign of meningeal irritation. *Motor system*—Voluntary power below the neck was limited to weak movements in the following groups: elevators of the shoulders, adductors of the arms, flexors of the left thumb and all groups in the lower limbs. The arm jerks were all present and the upper limbs were flaccid. The lower limbs were spastic and the jerks were lost. The abdominal reflexes were absent, the plantar responses were doubtfully extensor, and there was retention of urine with faecal incontinence. Diaphragmatic movement was normal. *Sensory system*—There was reduction of sensation to pinprick and cotton wool, and impaired temperature sensation from the upper chest downwards. Position sense was absent from

FIG. 3

FIG. 4

Antero-posterior radiographs of spine with lipiodol in theca. Figure 3—Spine flexed. Figure 4—Spine hyperextended.

FIG. 5

FIG. 6

Lateral radiographs of spine with lipiodol in theca. Figure 5—Spine flexed. Figure 6—Spine hyperextended.

all limbs and vibration was poorly felt at the wrists and left leg, and not felt in the right leg. *Radiographs* of the neck showed marked hypertrophic lipping and no fracture. Radiographs of the skull and chest were normal.

Treatment and progress—A skull caliper was applied and moderate flexion was maintained by light traction. In the following three days the only sign of neurological improvement was the recovery of some movement of all muscle groups in the upper limbs. On the fourth day broncho-pneumonia supervened and the patient died the next day.

Necropsy—Post-mortem examination showed extensive broncho-pneumonia. There was no other significant lesion outside the cervical spine, where there was a complete transverse tear of the anterior longitudinal ligament between the third and fourth cervical vertebrae (Fig. 2).

Detailed study of the cervical spine—The cervical spine was removed, lipiodol was injected

FIG. 7 FIG. 8

Sagittal section of cervical spine. Figure 7—Flexed. Figure 8—Hyperextended.

FIG. 9

Plasticine model indented by hyperextension of spine.

into the theca, and radiographs were taken with the neck fully flexed and extended (Figs. 3 to 6). In the extended position the column of opaque fluid is seen to be severed at the level of the rupture of the anterior longitudinal ligament. The lateral view shows the filling defect to be posterior. Lesser posterior indentations are seen at all other segmental levels.

The spine was divided in the median sagittal plane (Figs. 7 and 8) and the cord was replaced by a plasticine model. Figure 9 shows the indentations produced by hyperextension.

Mechanism of the cord injury—By relating the radiographs and the sagittal section of the spine in hyperextension (Figs. 6 and 8), it can be seen that the agent deforming the cord was the lamina of the fourth cervical vertebra with its overlying ligamentum flavum. This has moved upwards and forwards relative to the body of the third cervical vertebra, reducing the antero-posterior diameter of the canal by half. Smaller movements of the laminae above and below the lesion are seen to have caused the lesser indentations.

Nature of the cord injury—The neurological signs in the nervous system were those of a nearly symmetrical, predominantly posterior cord lesion at about the level of C.4–5. The loss of cutaneous sensation and motor function below the lesion was incomplete, but the loss of posterior column sensation was nearly complete, which suggested that the main force of the damage had been exerted from behind. A section of the cord (Fig. 10) at the level of the lesion supports these findings. No vascular lesion was seen, and sections made above and below the lesion showed no significant abnormality.

DISCUSSION

Paraplegia from hyperextension injury of the neck has been reported a number of times in recent years. Stress has been laid on the absence of radiological evidence of injury, and Barnes (1948, 1951) considered that pre-existing rigidity in an osteoarthritic neck was an

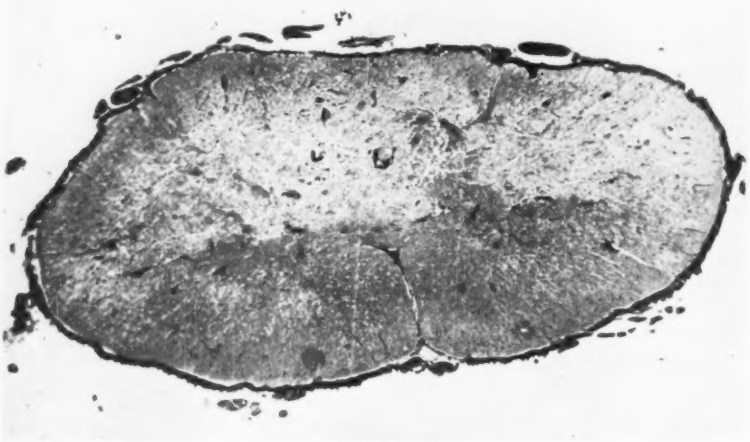

FIG. 10
Transverse section of spinal cord at C.3.

important clinical feature. The normal spine has enough flexibility to disperse amongst its several segments the angulation occurring during hyperextension, whereas such dispersion does not take place in a rigid spine, which snaps like a dry stick, concentrating angulation at one level. This is evidenced by the occurrence of paraplegia after spinal injury in patients with ankylosing spondylitis.

Of the mechanisms that have been put forward to explain the cord injury, Jefferson (1948) has dismissed as "an absurd notion" the proposal that there is spinal contusion without actual mechanical contact. Barnes (1948) considered that nerve traction might explain a lesion higher than the level of the ligamentous damage to the neck but he was unable to support this hypothesis experimentally. Taylor and Blackwood (1948) observed that the anterior longitudinal ligament might be torn without radiographic evidence of bony injury. Taylor (1951) suggested that the posterior injury to the cord was caused by forward bulging of the ligamenta flava at the moment of hyperextension. He showed experimentally that such bulging occurs in normal and pathological subjects and that the level of injury in his case corresponded to the level of greatest intrusion of the ligaments into the canal.

Our observations confirm that the ligamenta flava bulge forwards during hyperextension sufficiently to deform a lipiodol column within the theca or to dent a plasticine model. However, we found no evidence of cord damage at these sites. We believe that the injury

to the cord in this case was produced by compression of the cord between the sharp upper edge of the lamina of C.4 and the flat posterior surface of the body of C.3. A similar mechanism appears to have operated in the first case of Taylor and Blackwood (*op. cit.*).

SUMMARY

1. The clinical and post-mortem findings are described of a patient who sustained a hyperextension injury of the neck with paraplegia.

2. There was no radiological evidence of fracture: osteoarthritis of the spine was present.

3. Evidence is presented that the cord was damaged from behind by the lamina of the vertebra below a tear in the anterior longitudinal ligament.

We wish to thank Dr A. R. Kelsall for permission to publish this case. We would also like to thank the staff of the Photographic Department of the Institute of Orthopaedics and Mr John Hadland for their assistance.

REFERENCES

BARNES, R. (1948): Paraplegia in Cervical Spine Injuries. Journal of Bone and Joint Surgery, **30–B,** 234.

BARNES, R. (1951): Mechanism of Cord Injury without Vertebral Dislocation. Journal of Bone and Joint Surgery, **33–B,** 494.

JEFFERSON, G. (1948): Paraplegia in Cervical Spine Injuries. Journal of Bone and Joint Surgery, **30–B,** 232.

KAPLAN, C. J. (1953): Cervical Hyperextension Injuries with Paraplegia. Journal of Bone and Joint Surgery, **35–B,** 97.

TAYLOR, A. R. (1951): Mechanism of Injury to the Spinal Cord in the Neck without Damage to the Vertebral Column. Journal of Bone and Joint Surgery, **33–B,** 543.

TAYLOR, A. R., and BLACKWOOD, W. (1948): Paraplegia in Hyperextension Cervical Injuries with Normal Radiographic Appearances. Journal of Bone and Joint Surgery, **30–B,** 245.

THE SURGICAL CORRECTION OF MANDIBULAR PROTRUSION AND RETRUSION

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The surgical correction of mandibular protrusion and retrusion has been a subject of absorbing interest since Hullihen, in 1849, described a case of osteotomy of the horizontal ramus. Since that time many surgeons have developed techniques in regard to the site of election, the method of approach, the instrumentation and the mechanics of immobilisation. The fact that in the published results the diversity of approach and the optimum time for operation have been so variable points only to a universal dissatisfaction with any one method. To-day the situation is singularly little changed and, comparatively recently, Thoma (1951) discussed this problem in an editorial analysis in relation to three articles by Kazanjian (1951) and Skaloud (1951), who were describing cases in which the osteotomy was performed in the ascending ramus, and by Scougall and Colvin (1951), who gave their technique for operative procedures on the horizontal ramus.

Therefore, it would palpably serve no useful purpose in this short paper to review all the separate techniques for the correction of the two deformities, except in so far as they have been influenced by the introduction of aseptic surgery, adequate immobilisation and antibiotics. In this respect operative procedures on the jaws have been rendered materially safer by the knowledge that, if given a reasonable apposition of the fragments and absolute immobilisation, union should take place. However, the diversity of operative technique is matched by the variety of methods of fixation which are described in the literature. Immobilisation, to be effective, should be rigid, should hold fast and should be simple in design. To my mind these qualifications are best fulfilled by the cast metal dental cap splint, and in Britain it is the procedure most commonly used except, for obvious reasons, in edentulous jaws.

In addition, the use of antibiotics has reduced to a negligible figure the incidence of post-operative infection in procedures that involve opening into the oral cavity. There should be to-day no real hazard to the patient if one of several techniques is involved, provided use is made of those advances already mentioned.

On the other hand, to choose an operation that will fulfil all criteria is a matter of difficulty and is not in my experience practicable. At the same time, it is my belief that the operation based on the method devised by Kostečka (1934) is as nearly applicable as most and it offers certain advantages which should make it the operation of choice in the majority of cases.

This operation, the technique and results of which have been described by Bowdler Henry (1946) and others, consists essentially of a blind osteotomy of the ascending ramus, the line of section being above the lingula and below the sigmoid notch.

Technique of Kostečka's operation. *Preliminary procedures*—Lateral skull radiographs are taken together with profile photographs, so that clinically the amount of displacement and any slight variation in the line of section can be approximately determined. Pre-operative dental study casts are taken and articulated in the optimum position, on the assumption that a horizontal push back or pull forward is to be effected. To this predetermined position cast dental cap splints are made with the appropriate method of intermaxillary fixation. Pre-operatively, cast metal cap splints are cemented and the patient is placed on a course of penicillin, this being regarded as the most suitable antibiotic.

Operation—At operation, which is usually performed under endotracheal anaesthesia with

the possible addition of one of the hypotensive drugs, a point is marked midway between the tragus of the ear and the angle of the mandible. Next a line is drawn to the inner canthus of the eye. A stab incision down to the posterior border of the ascending ramus is made, and a special seeker, which is a modified Reverdin's needle, is introduced. Since the operation is blind it is important that the point of the needle should strike the bone and remain in contact with the internal surface of the ramus until it reaches the anterior border. The handle is depressed and the point delivered until it bulges the skin below the line already drawn; a small incision will then release the point and allow it to protrude on the skin surface.

A Gigli saw is attached (Fig. 1), the needle is withdrawn and the mandible is divided (Fig. 2). The procedure is repeated on the opposite side and it should then be possible to place the mandible in its predetermined position and effect intermaxillary fixation (Fig. 3). When dividing the ramus it is important to stop sawing immediately this has been achieved

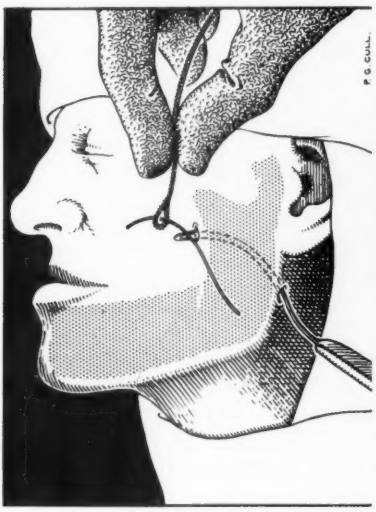

FIG. 1

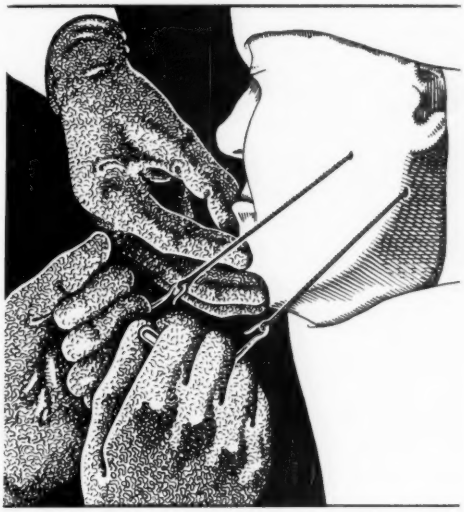

FIG. 2

Figure 1—Kostečka's operation. Special seeker in position and Gigli saw being attached. Figure 2—Ramus being divided by the saw. Patient's chin is supported by an assistant.

and at the same time to avoid unnecessary damage to the skin. The puncture wounds are closed by one or two atraumatic sutures. A stitch is placed through the tongue for traction, if required.

Post-operative management—The patient's recovery is carefully watched and the endotracheal tube is not removed until consciousness is about to be regained. In prognathism, which may be associated with macroglossia, it is important to see that no obstruction of the airway occurs from dropping back of the mandible and its attached structures being carried back. The nurse in charge should be ever watchful until full consciousness and tongue control are regained. Thereafter the treatment is the same as that for any case of fractured jaw immobilised by intermaxillary fixation. Immobilisation is maintained for three months at least; in most of my cases it has been maintained for fifteen weeks.

DISCUSSION

The operation has several advantages. It is expeditious, it does not sacrifice any teeth, it does not produce a noticeable scar, it should not involve damage to the facial nerve or the inferior dental nerve, and it does not open into the oral cavity. Moreover, it is a one-stage

procedure which, with adequate planning, can nearly always produce an acceptable cosmetic and functional result.

Its disadvantage, other than in exceptional cases where the articulation does not favour a simple slide in one plane, is that immobilisation must be retained for at least twelve weeks, and since it is a blind procedure there is a slight risk that a large vessel may be damaged. This latter hazard has not occurred in the author's experience or, to his knowledge, in any cases operated upon by his colleagues. Moreover, other procedures in this region which claim to be open operations, are so often devoid of access and visibility that this particular hazard almost remains.

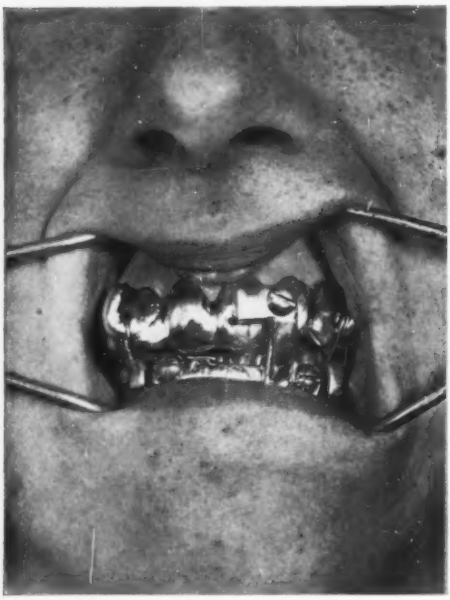

FIG. 3

Case 1—Metal cap splints in position with intermaxillary fixation by precision lock.

Another criticism is that non-union might occur in operations in this region, either from lack of control of the upper segment, allowing muscular action to favour separation of the fragments, or because thinness of the bone of the region and preponderance of cortical structure make for imperfect osseous union. While it is true that both these criticisms are theoretically valid, in practice osseous union appears to occur in every case, despite the fact that often the apposition of the bone fragments is minimal.

Selection of patients—The choice of case and the age at operation are matters of great importance. Many children with either mandibular protrusion or retrusion will respond to orthodontic treatment but others, because of the degree of abnormality or delay in seeking treatment, will not benefit by conservative treatment and it is in these cases that surgical correction offers the most hope. A decision as to whether orthodontic treatment has failed can often be made in the early teens and, certainly in prognathism, it would seem that after the age of fourteen years further orthodontic appliances, unless they have already been effective, are not likely to succeed. In mandibular retrusion, especially when it is combined, as it is so often, with a degree of superior protrusion, effective orthodontics can be continued to a later age. But in both conditions the age at operation is a matter of concern to patient and parent. Particularly is this so in a young girl who is at her most impressionable age.

Certain cases have been reported in the past of relapse after operation performed in the teens, and it has been assumed that this was due to a continuation of the essential error of growth that produced the disability. For that reason it has been advocated that operation should be postponed until after the twentieth birthday, when mandibular growth is judged to have ceased. However, there is a strong possibility that, in those cases of reported relapse, the degree of immobilisation and its duration have both been inadequate. The author has now operated upon four cases before the eighteenth birthday, the last case two and a half years ago, and the first five years ago, and in none has any relapse occurred. As a further criterion, it does appear that the right time to perform this operation is when the patient will receive the greatest psychological and physical benefit, and this undeniably is in late adolescence or early adult life.

CASE REPORTS

Case 1—Girl aged seventeen years. Mandibular protrusion.

The patient first came under observation at the age of fifteen years, when she was sent for an opinion as to the desirability of surgical correction of an established inferior protrusion. Some orthodontic treatment had been undertaken but it had been started late and it had not controlled the jaw relationship (Fig. 4). The girl was still at school and it was felt that she should wait for operation until she had left. At the same time orthodontic treatment was continued, not, however, with a view to correcting the deformity but to obtain such an alignment of the teeth that, if osteotomy were performed, a satisfactory dental occlusion could be obtained after displacement of the major fragment.

Operation was undertaken at the age of seventeen years according to the technique already described. The mandible was quite easily reduced to its predetermined position,

FIG. 4

FIG. 5

Case 1. Figure 4—Appearance of patient at age fifteen, before operation. Figure 5—Post-operative result at age seventeen.

intermaxillary wires were applied, and later a precision locking plate was fixed to the upper and lower splints. Recovery was without incident and the patient was in hospital for ten days.

The girl, who was a student pharmacist, returned to her employment at the end of three weeks, retaining the intermaxillary fixation until fifteen weeks after operation. During this period she lost a little weight but did not feel unduly tired or embarrassed by her appliance and inability to open the mouth.

Radiographs during this period of immobilisation showed fair apposition of the fragments although the upper fragments were slightly tilted outwards and forwards. Osseous union occurred on both sides and when the intermaxillary fixation was released and the splints removed the occlusion desired was obtained. No after-treatment was required and, as the photographs (Figs. 4 to 9) show, a satisfactory cosmetic result and sound functional occlusion

were achieved. Two and a half years later no relapse has occurred, the occlusion is maintained and the slight operative scars have faded into insignificance.

Case 2—Woman aged thirty years. Mandibular retrusion with maxillary overjet.

The patient was referred at a comparatively late age for correction of her facial deformity,

FIG. 6

FIG. 7

Case 1. Figure 6—Pre-operative study casts showing the articulation at the time. Figure 7—Post-operative study casts showing the new articulation obtained.

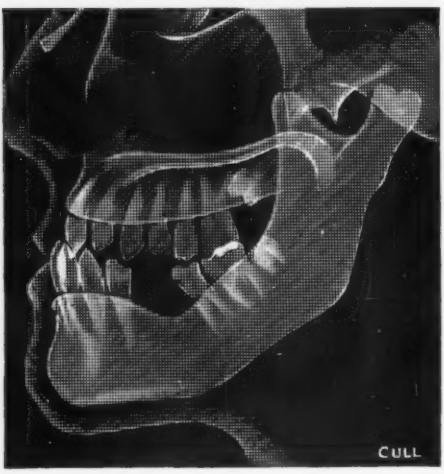

FIG. 8

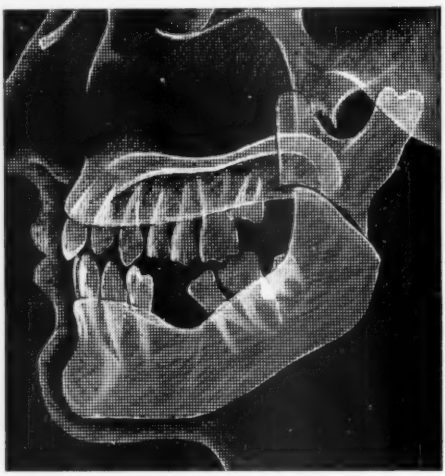

FIG. 9

Case 1—Composite diagrams taken from profile photographs and x-ray tracings, to show the line of section of the ascending ramus.

which was a combination of a severe mandibular retrusion with a protrusion of the upper incisor teeth (Fig. 10). In a preliminary study with models, it became obvious that relief would not be given by dealing with the maxillary overjet alone, nor would such a procedure improve the functional occlusion. It was decided that the most effective method would be to advance

the mandible by a bilateral osteotomy and, at a later date, to reduce the maxillary overjet and provide a partial denture. A bilateral osteotomy was performed and the mandible brought forward to a predetermined position. An advance of nearly half an inch was made. Immobilisation was maintained for sixteen weeks, when it was judged that clinical union had occurred.

FIG. 10

FIG. 11

Case 2. Figure 10—pre-operative photographs showing mandibular retrusion with corresponding maxillary overjet. Figure 11—Post-operative result of mandibular osteotomy and forward displacement.

FIG. 12

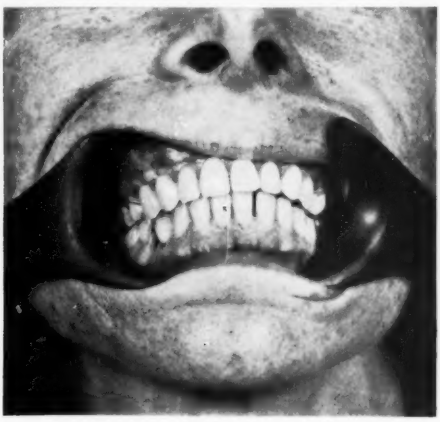

FIG. 13

Case 2. Figure 12—Final photograph after maxillary alveolectomy and provision of partial denture. Figure 13—Dental occlusion obtained.

Post-operative radiographs showed that the line of section on the left side was slightly higher than anticipated, being at the level of the sigmoid notch, so that the coronoid process had become detached from the rest of the fragment. However, there was no disturbance of function as a result of this, and bony union of the condylar neck to ramus was later demonstrable radiographically.

A material improvement in both masticatory ability and appearance was obtained by the osteotomy (Fig. 11) but the patient could still not freely oppose the lips because of the maxillary overjet and the shortness of the upper lip.

Six months after the first operation the upper alveolus was trimmed from canine to canine

FIG. 14

FIG. 15

Case 2. Figure 14—Pre-operative study casts. Figure 15—Post-operative study casts with dentures in position.

FIG. 16

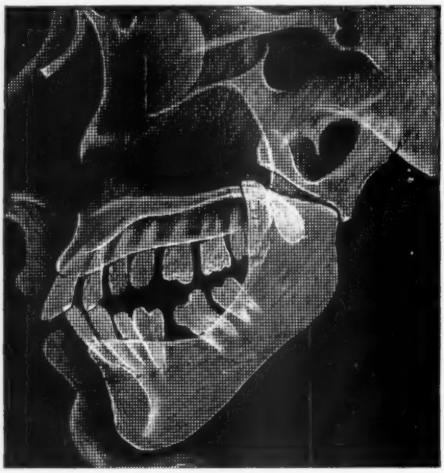

FIG. 17

Case 2—Composite diagrams taken from profile photographs and radiograph tracings, to show the line of section of the ascending ramus.

and a partial denture to replace the extracted teeth was fitted. The final result (Fig. 12) was satisfactory with a marked improvement in the functional occlusion of the teeth which, according to the patient, had given her the ability to masticate properly for the first time in her life (Figs. 13 to 17).

SUMMARY

1. The technique of correction of mandibular protrusion and retrusion by osteotomies through the rami of the mandible is described and illustrated.
2. The best age for the operation, and the factors that might favour or prevent relapse, are discussed.
3. Illustrative cases are described.

I wish to record my thanks to Mr Derek Martin, Director of the Photographic Department, The Hospital for Sick Children, Great Ormond Street, London, and to Mr P. Cull, the medical artist at the same hospital, for their excellent illustrations.

REFERENCES

HENRY, C. Bowdler (1946): Kostecka's Operation for the Correction of Mandibular Prognathism. British Dental Journal, **81,** 123.

HULLIHEN, S. P. (1849): Case of Elongation of the Under Jaw, and Distortion of the Face and Neck, Caused by a Burn, Successfully Treated. Baltimore: J. W. Woods.

KAZANJIAN, V. H. (1951): The Treatment of Mandibular Prognathism with Special Reference to Edentulous Patients. Oral Surgery, Oral Medicine and Oral Pathology, **4,** 680.

KOSTECKA, F. (1934): A Contribution to the Surgical Treatment of Open-Bite. International Journal of Orthodontia, **20,** 1,082.

SCOUGALL, S., and COLVIN, G. (1951): Functional Retention in Preangular Resection for Malocclusion in Protrusion of the Mandible. Oral Surgery, Oral Medicine and Oral Pathology, **4,** 695.

SKALOUD, F. (1951): A New Surgical Method for Correction of Prognathism of the Mandible. Oral Surgery, Oral Medicine and Oral Pathology, **4,** 689.

THOMA, K. H. (1951): Editorial. The Surgical Treatment of Jaw Deformities. Oral Surgery, Oral Medicine and Oral Pathology, **4,** 677.

FRACTURES COMPLICATING ELECTRO-CONVULSIVE THERAPY AND CHRONIC EPILEPSY

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From the Lancaster Moor Hospital

The use of electro-convulsive therapy has established itself in psychiatric practice. Opinion varies considerably about the risk of fractured limbs and spines. Accidental electric shocks have caused severe injuries to the spine and limbs, but with electro-convulsive therapy the passage of the current is briefer, the voltage is lower, the amperage is less and the size of the terminals is smaller. Nevertheless the current is sufficient to produce unconsciousness and epileptiform convulsions and in some cases contractions so great as to cause fracture of the spine or other bones. The least necessary to produce a major convulsion is about 100 volts and the duration about 0·3 second.

The present investigation was undertaken to assess the injuries (fractures and dislocations) complicating electro-convulsive therapy in a group of patients treated in the Lancaster Moor Hospital between 1942 and 1952. During this period of ten years 2,200 patients received electro-convulsive therapy from a single treatment to several series of treatments. In all, 37,000 convulsions were induced. Fractures of the spine, humerus, femoral neck and scapula were noted. The site distribution of the fifty-three fractures and dislocations is shown in Table I.

TABLE I

DISTRIBUTION OF SITE OF INJURY

Spine	Neck of femur	Upper humerus	Coracoid process	Dislocated jaw	Total
21	15	15	1	1	53

The reported incidence of such injuries among patients receiving electro-convulsive therapy varies. Fractures occurred in 1·1 per cent of 3,000 patients treated by Meduna and Friedman (1939), excluding vertebral fractures. Nine patients among 1,000 treated by Kolb and Vogel (1942) sustained fractures. Worthing and Kalinowsky (1942) reported sixty patients treated without a fracture. Samuel (1943) recorded twelve fractures (2·8 per cent) among 420 patients.

The method employed to produce the convulsion in this series of cases was as follows. The patient lies on a bed upon an ordinary firm mattress. A small pillow is placed under the lower thoracic spine. One nurse controls the shoulders, one the thighs and the third places a gag in the mouth and controls the jaw, so that the tongue cannot be bitten and the mouth cannot be opened excessively. (One case of dislocated jaw occurred which required manipulation under general anaesthesia later to reduce it.) The electrodes are placed on the temple and the current is switched on. The common starting dose is 130 volts for 0·3 second; if a heavier dosage is required for subsequent shocks the voltage is raised, but it is not increased beyond 150 volts for 1 second. Treatment is repeated on alternate days.

FRACTURES OF THE SPINE

Twenty-one cases of fractured spine occurred—about 1 per cent of the cases treated. Table II shows the distribution of fractured vertebrae. Of the twenty-one cases seventeen

TABLE II

THE DISTRIBUTION OF FRACTURED VERTEBRAE

Thoracic vertebrae	4	5	6	7	8	9	10	11	12					
Lumbar vertebrae										1	2	3	4	5
Number of times fractured	5	4	5	5	2	2	2				1 (one case)		1	

TABLE III

NUMBER OF VERTEBRAE FRACTURED

Number of vertebrae fractured	Incidence	
	Male	Female
One . .	9	8
Two . .	2	—
Three . .	1	1

showed a fracture of a single vertebra, two a fracture of two adjacent vertebrae (T.4 and 5) and two a fracture of three vertebrae (Table III).

The fractures occurred throughout the thoracic spine with the exception of one case in the lumbar region in which fractures of L.2 and L.4 were combined with a fracture of T.10. The commonest site of fracture was at T.4, 5 or 6 (Fig. 1). Fractures below the level T.7 were uncommon (Fig. 2) and there was no case of fracture in the cervical region.

FIG. 1

FIG. 2

Figure 1—Anterior wedge fracture of T.4 in a woman aged fifty-four, sustained during the fourth electro-convulsion. There is no comminution and the disc spaces above and below the fracture are well preserved. Figure 2—Anterior wedge fracture of T.8 in a woman of forty-five, sustained during the second electro-convulsion. There is also a depression in the centre of the superior surface of T.8 where the disc has herniated into the body. T.5 is also fractured.

All the fractures were confined to the bodies of the vertebrae, there being no involvement of the spines, laminae or pedicles. There was no case of hyperextension fracture, fracture-dislocation or cord damage. No deaths due to fractured spine occurred. The segment of the spine T.4 to T.7 is the most vulnerable and here the spine has the least flexibility and is subjected to powerful muscle action.

Most fractures (80·9 per cent) occurred during convulsions other than the first (Table IV). This might suggest that damage leading to softening is caused by the first or early convulsions.

TABLE IV
INCIDENCE OF FRACTURE RELATED TO NUMBER OF TREATMENTS

Convulsion	Number of cases showing fracture
First . .	4
Second .	8
Third . .	2
Fourth .	5
Fifth . .	1
Seventh .	1
80·9% occurred after convulsions other than the first	

TABLE V
RECORD OF CASES OF FRACTURED SPINE

Sex	Age	Convulsion at which fracture occurred	Site of fracture
F	54	4	T.4
F	56	2	T.4
M	29	2	T.4
M	18	3	T.4 and 5
M	38	2	T.4 and 5
M	65	1	T.5
F	49	4	T.6
F	59	4	T.6
F	58	3	T.6
M	47	2	T.6
M	53	1	T.6
F	22	1	T.7
M	53	2	T.7
M	57	4	T.7
M	62	5	T.7
M	28	2	T.7, 9 and 10
F	45	2	T.8
M	45	1	T.8
F	38	7	T.9
F	54	4	T.10, L.2 and 4
M	73	2	T.5

Brailsford has termed the fracture "the disc repercussion fracture" because it gave the impression that the disc surfaces had been hammered out by repeated blows. The fracture usually shows as a depression of the superior surface of the vertebral body and in the antero-posterior view this shows as a horizontal line of increased density (Figs. 3 and 4). The lateral view is the more valuable. It is not always easy to get a good lateral film of the upper thoracic spine and the overlapping glenoid cavity makes interpretation of any but the best quality films difficult.

Table V shows details of each of the twenty-one cases of fractured spine.

FIG. 3

FIG. 4

Figure 3—Disc repercussion fracture. There is depression of the superior surface of T.6 with enlargement of the disc space between T.5 and 6. Figure 4—Anterior wedge fracture of T.4 showing the fractured vertebral body as a horizontal line of increased density.

FIG. 5

Bilateral fractures of neck of femur in man of thirty-nine years during the first electro-convulsion. He died within twenty-four hours from acute pulmonary oedema.

FRACTURES OF THE FEMUR

Fifteen cases of fractured neck of femur occurred (Table VI).

The high incidence of fracture after convulsions other than the first is again noted (Table VII).

The site of fracture was through the neck of the femur and in no case was there a coincident fracture of other bones. In one case bilateral fracture of the neck of the femur occurred during the first convulsion (Fig. 5). This was in a man of thirty-nine years. He died within twenty-four hours from acute pulmonary oedema confirmed at necropsy. There was one case of advanced Paget's disease. Treatment of these fractures was along the usual lines, either by nailing or by osteotomy.

TABLE VI

CLINICAL DETAILS IN FIFTEEN CASES OF FRACTURE OF THE NECK OF THE FEMUR

Number of cases	Average age	Sex		Side		Incidence of fracture
		M	F	Right	Left	
15	53 years	6	9	11 (one bilateral)	5	0·7% of 2,200 cases treated 28·3% of the 53 cases of fracture

TABLE VII

INCIDENCE OF FRACTURE RELATED TO NUMBER OF TREATMENTS

Convulsion	Number of cases with fractured neck of femur
First	2
Second	5
Third	4
Fourth	1
Fifth	1
Sixth	2
86·6% of fractures occurred after convulsions other than the first	

FRACTURES OF THE UPPER HUMERUS

It is generally agreed that fractures of the upper extremity during electro-convulsive therapy occur almost exclusively around the shoulder joint. Such fractures occurred in fifteen cases, the average age being forty-nine years, with a sex incidence of two females to one male. The type of fracture varied from a simple avulsion of the greater tuberosity to a comminuted fracture-dislocation of the upper end of the humerus. No case of dislocation of the humeral head without fracture was observed. In two cases the dislocation was posterior. Posterior dislocation of the humerus during convulsive therapy has been previously recorded by Samuel (1943). Two of the cases showed associated fracture of the scapula, one of the axillary border near the lower angle and the other of the anterior margin of the glenoid cavity. No fracture occurred in the first two convulsions (Table VIII).

DISLOCATION OF THE JAW

Dislocation of the jaw either on one or both sides is a fairly frequent occurrence and reduction is performed at a stage when the muscular contractions are becoming less.

Occasionally this is not possible and a general anaesthetic is required later to reduce the dislocation. One such case is included in this series.

TABLE VIII

INCIDENCE OF FRACTURE RELATED TO NUMBER OF TREATMENTS

Convulsion	Number of cases of fracture or fracture-dislocation of upper humerus
First . .	0
Second . .	0
Third . .	1
Fourth . .	3
Fifth . .	1
Sixth . .	5
Eighth . .	3
Eleventh .	1
Nineteenth .	1

DISCUSSION

Fatal complications of electro-convulsive therapy are rare and in this series of 2,000 cases there was only one death. The severity of the injury in the fractured spines was not great, fixation was not necessary and no neurological lesions occurred. Six patients who had sustained fractured spines not less than two years before were examined. They had no complaint of pain or tenderness. There was a slight kyphosis noticeable in two patients only. The fractured vertebrae had consolidated well and the disc spaces were well preserved (Figs. 6 and 7). In contrast, fracture of the neck of the femur is a serious injury, as is also fracture-dislocation of the humerus. With these patients the accepted and desired methods of treatment cannot always be applied and it is a matter of experience to choose a method that will be satisfactory in the individual case. Sogliani (1939) reported a fracture of the greater trochanter but, apart from this, fractures of the lower limb other than of the femoral neck have not been recorded. Although fracture of the femoral neck is a rare injury during electro-convulsive therapy, when it occurs it is often bilateral (Somers and Richardson 1939).

In two cases of fracture-dislocation of the shoulder the dislocation was posterior. This injury was possibly due to the upper humeral shafts being held while the spine and scapulae came forwards in the initial flexion phase of the convulsion. Any restraint considered necessary to the upper limbs should be applied to the front of the glenoids rather than to the humeral shafts. Meggendorfer (1940) actually recommended pulling the upper arm forwards during the convulsion. Other fractures in the upper limb, except fractured scapula, are very uncommon.

It is generally agreed that the incidence of fracture has been reduced since electro-convulsive therapy replaced cardiazol. According to Smith *et al.* (1942) the incidence of fractures has been reduced from 22 per cent to 5 per cent. Nevertheless fractures do occur in spite of precautions and technical advances, and in many cases no predisposing factor can be found. It is interesting that the greatest incidence of fracture of the spine occurs in the upper thoracic and mid-thoracic regions whether the convulsions are induced electrically, by cardiazol, or by tetanus. The wedging of the vertebra suggests that it might be brought about by the sudden flexion spasm which occurs sometimes at the beginning of the fit. The

fact that posterior dislocation of the humerus occurred on two occasions also favours the view that the injury occurred at the flexion stage of the convulsion. The second type of fractured vertebra seen was the "disc repercussion" fracture in which the disc is forced into the vertebral body by fracture of its superior surface. It is suggested that this is due to severe longitudinal compression of the spine, and the most likely time for this to occur is when the patient is in opisthotonos. Hence a neutral position of the spine, neither flexed nor hyperextended, during the fit is desirable to diminish the risk of fracture, and the intensity of the convulsion should be lessened either by the administration of a relaxant such as a curare preparation or "by inducing slowly developing seizures by means of the lowest possible current intensity" (Kalinowsky and Hock 1952).

FIG. 6

FIG. 7

Wedge fracture T.8 and 9 in woman of thirty-eight complicating the seventh electro-convulsion (Fig. 6). The patient was treated without immobilisation and seven years later was re-examined and found free from symptoms. The fracture has consolidated and the disc spaces above and below are well preserved (Fig. 7).

FRACTURES IN CASES OF PSYCHOSIS WITH CHRONIC EPILEPSY

Having noted that the incidence of fracture during electro-convulsive therapy was 2·4 per cent, of which fractured spine accounted for 1 per cent, the writer decided to examine cases of psychosis with chronic epilepsy and to determine the incidence of fracture, if any, in these cases and compare it with that complicating electro-convulsive therapy. Fifty-two patients were examined, of whom twenty-four were women and twenty-eight men; the thoraco-lumbar spine was radiographed in all. Fractures were not known to have occurred in any of these cases. No fracture of the long bones was found. Four cases of fracture of the spine were discovered, an incidence of 7·7 per cent. The incidence of fractured spine as reported in epileptics varies considerably. Cook and Sands (1941) found it to be 10·4 per cent. Caplan (1946) found nine fractures (33 per cent) in twenty-seven epileptic patients, mostly in the lower thoracic spine. Reed and Dancey (1940) reported an incidence of 34·2 per cent. Worthing and Kalinowsky (1942) found two fractures in forty-two epileptics. Others report

an incidence of up to 66 per cent (Moore, Winkelman and Solis-Cohen 1941). The four cases in this series concerned men with an average age of sixty-one years. The average age of male epileptics examined was 45·7 years. The average age of female epileptics examined was forty-nine years. Age does not appear to be an important factor in the causation of fractured spine in these cases. The fact that all the fractures occurred in men is probably due to their more powerful musculature.

TABLE IX

SITE OF SPINAL FRACTURE IN FOUR EPILEPTIC PATIENTS

Sex	Age	Site of fracture
M	66	T.7 L.3
M	47	T.8
M	54	T.12
M	77	L.3 and 4

The site of the fracture differed from that of fractures complicating electro-convulsive therapy (Table IX). No fracture of the thoracic spine above T.7 was found. There was one case of fracture in the lumbar spine alone (L.3 and 4). In half of the cases one vertebra was involved—namely T.8 and T.12; in the other half two vertebrae were affected (Fig. 8). Because of the patients' mental state it was not possible to get a reliable history of the onset of backache

TABLE X

COMPARISON OF FRACTURES CAUSED BY ELECTRO-CONVULSIVE THERAPY WITH THOSE CAUSED BY CHRONIC EPILEPSY

	Electro-convulsive therapy	Chronic epilepsy
Number of cases examined	2,200	52
Sex	1 M : 0·83 F	1 M : 0·86 F
Incidence of all fractures	2·4%	7·7%
Incidence of fractured spine	1·0%	7·7%
Average age of patients with fractured spine	48 years	61 years
Site of fracture	81% in single vertebra	50% in single vertebra
Commonest site of fracture	T.4, 5 or 6	Lower thoracic and lumbar
Type of fracture	Wedge or disc repercussion	Wedge or disc repercussion
Other fractures	Femur, humerus, scapula, dislocated jaw	No other fractures found

after a fit, but all the fractures appeared of long standing. The type of fracture was similar to that complicating electro-convulsive therapy, the body of the vertebra alone being involved; in one case the radiographs showed a marked concavity of the upper surface of the body of L.3 with the disc spaces on both sides well preserved. This was an old " disc repercussion " fracture, similar to that found after electro-convulsive therapy (Fig. 9).

It has been stated that these fractures are quite different from those seen after convulsive therapy (Worthing and Kalinowsky 1942) (Table X). It is suggested that they might be due to

the actual fall. However, it can be seen from this group of cases that, as in fractures of the spine caused by electro-convulsive therapy, the body of the vertebra alone is affected, and in one case there was a marked concavity of the upper surface of the vertebral body with herniation of the disc into the vertebral body. This was an old " disc repercussion " fracture similar to that found after electro-convulsive therapy. The difference in the site of fracture in the two groups might be explained by the fact that some epileptics are standing when the fit occurs, whereas patients having electro-convulsive therapy are lying down and the fit is controlled. When the patient is standing the knees are extended and the pelvis is fixed by the strong hamstring muscles. Forced flexion of the spine at this stage puts considerable stress on the lumbo-sacral region and lower half of the spine. Hence it is suggested that the site of fracture is different from that complicating electro-convulsive therapy because the fulcrum of movement is lowered from the upper thoracic level.

FIG. 8

FIG. 9

Figure 8—Old wedge fracture L.3 and 4 in male chronic epileptic aged seventy-seven. This was the only case amongst the epileptics in which fracture of the lumbar spine alone occurred. Figure 9—Old disc repercussion fracture in male chronic epileptic. There is well marked concavity of the upper surface of the body of L.3 with relative enlargement of the disc space between L.2 and 3. This patient also had an anterior wedge fracture of T.7.

SUMMARY

1. A study of 2,200 patients receiving electro-convulsive therapy showed that fifty-three sustained fractures or dislocations—an incidence of 2·4 per cent. Of the fifty-three injuries, twenty-one occurred in the spine, fifteen in the neck of femur, fifteen in the upper end of humerus, one in the coracoid process; one dislocated jaw required anaesthesia for its reduction (other cases of transient dislocation of the jaw are excluded).

2. The incidence, site, and type of spinal fractures are recorded, and the relation of the fracture to the first convulsion is noted. No late changes were found in the spines of patients examined two years or more after treatment. A neutral position of the spine during the convulsion is believed to diminish the risk of fracture.

3. Fracture of the neck of the femur is a serious injury in these patients. In one case the injury was bilateral.

4. The fifteen cases of fracture-dislocation of the upper humerus are analysed. They included two cases of posterior dislocation of the humeral head; the possible mechanism of this is explained and a method of prevention suggested.

5. Fifty-three patients with chronic epilepsy with psychosis were examined. Four cases of fractured spine were discovered. The site of fracture was different from that of fractures caused by convulsive therapy and a reason for this is suggested. The type and mechanism of the fracture are similar in the two groups.

I am most grateful to Mr Ian D. Kitchin for his helpful advice and criticism; and to Dr J. Silverston, Medical Superintendent, Lancaster Moor Hospital, without whose help it would have been impossible to gather the necessary data.

REFERENCES

BRAILSFORD, J. F. (1948): The Radiology of Bones and Joints. Fourth edition, 392. London: J. & A. Churchill Ltd.

CAPLAN, G. (1946): Fractures of Dorsal Vertebrae in Epilepsy and Convulsion Therapy. Journal of Mental Science, **92,** 766.

CERLETTI, U., and BINI, L. (1938): Bollettino della R. Accademia Medica, Roma, **64,** 36.

COOK, L. C., and SANDS, D. E. (1941): Spinal Injuries in Convulsion Therapy. Journal of Mental Science, **87,** 230.

KALINOWSKY, L. B., and HOCK, P. H. (1952): Shock Treatments, Psychosurgery and Other Somatic Treatments in Psychiatry, **154.** New York: Grune & Stratton Inc.

KOLB, L., and VOGEL, V. H. (1942): The Use of Shock Therapy in 305 Mental Hospitals. American Journal of Psychiatry, **99,** 90.

MEDUNA, L. (1937): Die Konvulsionstherapie der Schizophrenie. Halle: Marhold.

MEDUNA, L. von, and FRIEDMAN, E. (1939): The Convulsive-Irritative Therapy of the Psychoses. Journal of the American Medical Association, **112,** 501.

MEGGENDORFER, F. (1940): Elektrokampfbehandlung der Psychosen. Deutsche Medizinische Wochenschrift, **66,** 1,155.

MEGGENDORFER, F. (1942): Zur Klinik des Elektrokrampfes. Nervenarzt, **15,** 49.

MOORE, M. T., WINKELMAN, N. W., and SOLIS-COHEN, L. (1941): Asymptomatic Vertebral Fractures in Epilepsy. Journal of Mental and Nervous Diseases, **94,** 309.

REED, G. E., and DANCEY, T. E. (1940): Compression Fractures of the Vertebral Bodies Following Induced and " Idiopathic " Convulsions. Canadian Medical Association Journal, **N.S. 42,** 38.

SAMUEL, E. (1943): Some Complications Arising During Electrical Convulsive Therapy. Journal of Mental Science, **89,** 81.

SOGLIANI, G. (1939): Elettroschockterapia e cardiazolterapia. Rassegna di studi psichiatrici, **28,** 652.

SOMERS, D. C., and RICHARDSON, R. P. (1939): Bilateral Fracture of the Femoral Necks Caused by Metaazol Convulsions. American Journal of Psychiatry, **95,** 1,193.

SMITH, L. H., HUGHES, J., HASTINGS, D. W., and ALPERS, B. J. (1942): Electroshock Treatment in the Psychoses. American Journal of Psychiatry, **98,** 1,193.

WORTHING, H. J., and KALINOWSKY, L. B. (1942): The Question of Vertebral Fractures in Convulsive Therapy and in Epilepsy. American Journal of Psychiatry, **98,** 534, 535.

POST-TETANIC KYPHOSIS

Report of a Case

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The occurrence of kyphosis from multiple fractures is a complication of tetanus that has received little attention in the English literature. It has been reported frequently in Continental countries, but only three accounts can be found in the English language, and all of these come from the United States (Roberg 1937, Rand 1938 and Dietrich *et al.* 1940).

The condition is interesting in that it might appear at first sight that compression fractures of the spine have been produced by a hyperextension force—an apparent contradiction of the usually accepted views on the mechanism of this injury. For this reason it has been called " a paradoxical symptom complex " (Rand 1938).

CASE REPORT

A girl of seven fell from her bicycle and sustained a minor abrasion to the right knee. This was dressed at home and her doctor was not consulted. Sixteen days later she developed abdominal pain which gradually became more severe during the next few days. Three weeks after the injury she was admitted to hospital with an " acute abdomen " and appendicectomy was performed.

The following day some stiffness of the jaw was noticed. Two days later tetanic muscular spasms developed, with opisthotonos, trismus and generalised rigidity. Anti-tetanic serum, penicillin, relaxant drugs and intramuscular paraldehyde were administered. During the next nine days mild attacks of twitching and opisthotonos were observed, especially at night, and rigidity was marked. At the end of that time rigidity had diminished and there were no further spasms. Convalescence was uneventful, and she was sent home after three weeks in hospital. At no time did she complain of pain in her back. The muscle spasms were never severe and always predominantly extensor.

Soon after the child returned home her parents noticed that she was shorter by about two inches than before her illness, and that she had become round-shouldered.

When she was seen at the orthopaedic clinic five weeks after the onset of tetanus there was a generalised upper thoracic kyphosis, which could not be corrected actively or passively (Figs. 1 and 2). There was slight tenderness over the upper thoracic spinous processes. Movements of the thoracic spine were all restricted. There was a residual muscular rigidity in the legs which caused her to walk slowly with a " shuffling " gait. Examination of the central nervous system revealed no other abnormality. Radiographs showed kyphosis, with marked flattening and wedging of the bodies of the fourth, fifth and sixth thoracic vertebrae, and, to a lesser extent, wedging of the third, seventh and eighth (Fig. 3). There was some sclerosis of the affected vertebrae. The disc spaces were unaffected. *Treatment and progress*—The patient was admitted to hospital and immobilised on a frame with a sunken head piece to extend the affected part of the spine. Immobilisation was continued for seven weeks. During this time there had been no change in the radiographic appearance of the individual vertebrae but the spinal curvature as a whole was less.

After a course of hyperextension and postural exercises under supervision in hospital, the patient was sent home with instructions to continue these exercises, and has since been under observation.

FIG. 1

FIG. 2

Figure 1—Photograph on admission to hospital showing degree of upper thoracic kyphosis and forward protrusion of head and neck. Figure 2—Arms elevated to remove scapulae from profile of thoracic spine.

FIG. 3

FIG. 4

Figure 3—Lateral radiograph of thoracic spine on admission. Figure 4—Lateral radiograph of thoracic spine five months after illness.

During her stay in hospital biochemical investigations of blood and urine revealed no evidence of any generalised skeletal abnormality.

Nine months after her illness there was still a thoracic kyphosis. This was not worse than that often observed in children of school age. The loss in height persisted and the trunk appeared short and squat. The child was free from symptoms and was back at school. Radiographs showed that the vertebrae remained collapsed, but that a compensatory curve had developed above and below the affected segment. The lessening of the kyphosis was maintained (Fig. 4).

DISCUSSION

There seems little doubt in this case that the hyperextension spasms of tetanus produced crush fractures of the vertebral bodies. There was no evidence of any generalised disease or other factor which would suggest that the fractures were " pathological " in nature. The history, clinical and radiographic features distinguished the condition quite clearly from Scheuermann's disease, Calvé's disease and spinal tuberculosis.

Mechanism of production of the lesion—Several hypotheses have been put forward by previous writers to explain the production of these fractures. " *Toxic theory* "—Tetanus toxin is stated to have a direct action on bone causing an osteoporosis and weakening which leads to collapse. *Vascular theory*—Repeated spasms of muscles round the vertebrae compress the nutrient vessels and produce congestion according to some writers, and anaemia according to others. This predisposes to collapse (Brunzel 1919). " *Tetanus en boule* "—A rare form of tetanus in which the spasms are frankly flexor in character and in which crush fracture would be expected. I have found only one account of this form of tetanus having been observed in a case of post-tetanic kyphosis (Ribó 1946).

Mechanical theory—The area of the spine affected by collapse after tetanus is remarkably constant. T.5 is the vertebra most commonly affected, with T.6 the next in frequency. Often as many as six or seven vertebrae show varying degrees of change, but the apex of the gibbus so produced is always at T.5.

Dietrich, Karshner and Stewart (1940) pointed out that the resultant force acting on the whole vertebral column as a result of simultaneous contraction of the flexors and extensor muscles is one of longitudinal compression. This will have the effect of forcibly increasing the normal spinal curves. Thus one will see hyperextension of the lumbar and cervical regions and the patient will lie in the classical position of " opisthotonos "; but in this position the upper thoracic spine is acutely flexed. Crushing of thoracic vertebrae results.

Roberg (1937) had previously explained the condition on different anatomical grounds. He stated that the spinal extensor muscles were weakest in the upper thoracic region, the interspinales being frequently absent. The full force of the trunk flexors, acting through the leverage of the ribs, would be concentrated at this point and flexion would be produced here. In addition, by studies of vertebral strength in resisting compression forces, he demonstrated that the upper thoracic vertebrae were the weakest in the spinal column. Moreover, their ability to withstand any one compression force was reduced by submitting them previously to repeated blows, each one in itself insufficient to produce collapse. This would explain the production of vertebral crush fractures by the repeated muscle spasms of tetanus. Roberg had rejected the supposition that an increase in the normal spinal curves is the cause of post-tetanic kyphosis on the grounds that if this were so the lesion could be expected at the apex of the normal curve. It has been stated that the commonest vertebra involved is T.5. According to Roberg the apex of the thoracic curve lies lower down.

A combination of the factors mentioned in these two mechanical theories seems to give a satisfactory explanation of the production of the vertebral collapse. The apex of the thoracic curve would be higher than normal during generalised spasms because of the flexor-extensor balance of the region and this temporary apex would suffer the full compression force.

A close parallel to this form of vertebral fracture is seen in the spinal fractures produced by the various forms of convulsive therapy, although the mechanism varies in these cases. The following features are common to these fractures and to the fractures complicating tetanus. 1) T.5 and T.6 are the vertebrae most frequently affected. 2) The vertebral lesions cause surprisingly few symptoms and probably occur more frequently than is suspected.

In this connection it is worth noting that Dietrich, Karshner and Stewart estimated that the spine is affected in 70 per cent of cases of tetanus in children who recover. Thus it is likely that post-tetanic kyphosis is not as rare as one would expect, even allowing for the fact that tetanus is fortunately an uncommon disease in this country.

SUMMARY

1. A case of post-tetanic kyphosis is reported.
2. The clinical and radiographic features are described.
3. The theories of the mechanism of production of the deformity are discussed.

My thanks are due to Mr C. S. Walker for his interest and advice.

REFERENCES

BRUNZEL, H. F. (1919): Über Gibbusbildung nach allgemeinem und lokalem Tetanus. Deutsche Zeitschrift für Chirurgie, **150,** 258.

DIETRICH, H. F., KARSHNER, R. G., and STEWART, S. F. (1940): Tetanus and Lesions of the Spine in Childhood. Journal of Bone and Joint Surgery, **22,** 43.

RAND, C. W. (1938): Post-tetanic Gibbus-Paradoxical Symptom Complex: report of three cases. Bulletin of the Los Angeles Neurological Society, **3,** 141.

RIBÓ RÍUS, L. (1946): Fractura Vertebral por Tétanos. Medicina Clínica, año **4,** t.**6,** 273.

ROBERG, O. T., Jun. (1937): Spinal Deformity Following Tetanus and its Relation to Juvenile Kyphosis. Journal of Bone and Joint Surgery, **19,** 603.

INJURIES TO THE LATERAL CONDYLE EPIPHYSIS OF THE HUMERUS IN CHILDREN

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This article deals with the mechanism of production and the method of reduction of injuries of the lateral condylar epiphysis of the humerus. These injuries are usually described as affecting the capitulum, but, as noted by Roberts (1936) and Watson-Jones (1943), the detached fragment consists of the capitular epiphysis and the lateral third of the trochlea with a fragment (common to all epiphysial injuries) of the humeral metaphysis. The line of fracture is remarkably constant.

MECHANISM OF PRODUCTION

The usual view is that the extensor muscles avulse the fragment from its bed, causing displacement which varies from a downward and lateral displacement (usually also backwards) to rotation of the fragment. It is difficult to believe that muscular effort alone would cause this. Moreover, when the medial epicondyle is avulsed, without dislocation of the elbow, the displacement is never marked. Our belief is that the elbow is dislocated postero-laterally

FIG. 1

Displacement of lateral condyle epiphysis with rotation of the fragment. Although clinically there may be no apparent dislocation at the time of examination, it is believed that the mechanism of the injury is a dislocation of the elbow with spontaneous (but usually incomplete) reduction.

and carries the fragment with it. If the dislocation is incomplete the fragment moves downwards, laterally and backwards. If the dislocation is more marked the fragment is pulled backwards. Dislocation associated with fracture renders the joint unstable in all directions. The dislocated joint surfaces can fall forwards approximately into their normal position and the fragment lies anterior to the humerus. Clinically no dislocation appears to be present (Fig. 1). This hypothesis of causation gives the clue to successful closed reduction.

TECHNIQUE OF CLOSED REDUCTION

The method of reduction consists in redislocating the elbow postero-laterally, then reducing it, when the fragment settles in its bed accurately. The fragment itself does not require to be pressed into position but care must be taken to move the radius and ulna

FIG. 2
Case 2—Before reduction

FIG. 3
Case 2—After manipulative correction by redislocating the joint and then reducing it without applying local pressure to the displaced fragment.

medially to get accurate apposition. In one case manipulation seemed to be unsuccessful until it was realised that full reduction was possible only by pressing medially on the forearm, when the fracture became stable. Figure 2 shows an obvious fracture-dislocation of the elbow which appears to be a medial dislocation, but reduction could only be made by first

pushing the elbow laterally, and then bringing it medially into position again. This gave accurate reduction (Fig. 3). Another case is illustrated in Figures 4 and 5. Figure 4 shows non-articulation of the ulna with the humerus and the fragment lies anteriorly. Figure 5 shows accurate reduction by redislocating the elbow, then reducing it. Figures 6 and 7 show

FIG. 4
Case 7—Before reduction.

FIG. 5
Case 7—After manipulative reduction.

a further case. In Figure 6 the fragment is trapped between the surfaces and the ulna does not articulate accurately with humerus. Reduction by the manipulation described was again successful (Fig. 7).

The bad results of missed injury seem to depend upon the ulna being in poor apposition

with the trochlea rather than upon bad positioning of the condylar epiphysis. In the radiographs illustrated the ulna is not in proper alignment with the humerus in any of the cases before manipulation. In one late case in which the displacement was overlooked operation was undertaken to replace the fragment. The condylar epiphysis was dissected

FIG. 6
Case 9—Before reduction.

FIG. 7
Case 9—After manipulative reduction.

away from the humerus and, on exploring the rest of the joint, it was discovered that the remaining trochlear cartilage was non-existent and the lower end of the humerus covered with fibrous tissue to fill the gap between the non-articulating bones. In cases in which the condyle is displaced slightly downwards and laterally the head of the radius still articulates

with the fragment and it seems probable that movement is impaired because the ulna does not articulate properly with the trochlea.

We suggest that elbow injuries in children might be classified as follows: 1) dislocation of

FIG. 8

A recent case before reduction. Note rotation of the large separated fragment.

FIG. 9

Accurate reposition achieved by manipulation.

the elbow; 2) dislocation of the elbow with fracture of the medial epicondyle; 3) dislocation of the elbow with fracture of the lateral condyle epiphysis.

CASE REPORTS

Since 1944 nine injuries of this type have been treated successfully by closed reduction. Eight cases have been followed up and their main features are summarised on page 89.

Case 1—This was the first case reduced by manipulation in 1944. Eight years later function was perfect. Radiographs showed a normal joint.

Case 2—Patient not traced for follow-up (Figs. 2 and 3).

Case 3—Function was normal three and a half years after reduction. Radiographs showed sound union of the fragment to the humerus.

Case 4—One year and three months after reduction flexion of the elbow was full; extension was to 150 degrees. There was obvious thickening over the fragment. Radiographs showed slight lateral displacement of the fragment, but good union to the humerus.

Case 5—Full function was present one and a half years after reduction.

Case 6—When examined three months after reduction flexion of the elbow was full; extension was to 160 degrees.

Case 7—Three months after reduction flexion of the elbow was full. Extension was to 160 degrees. There was palpable thickening over the fragment (Figs. 4 and 5).

Case 8—Three months after reduction flexion was full; extension was to 150 degrees. Slight thickening over the fragment.

Case 9—On examination eight months after reduction the function of the elbow was normal (Figs. 6 and 7).

SUMMARY

1. The mechanism of production of injury to the lateral condyle epiphysis is discussed.
2. A technique of closed reduction of rotational displacements of the epiphysis is described. Nine cases in which the method was successful are noted.
3. It is suggested that the injury should be classified with dislocation of the elbow.

Addendum—Since this article was submitted two more cases have been treated. The first case is interesting in that pressure on the fragment was used in an attempt to facilitate reduction. Far from helping reduction, it caused the fragment to rotate upside down and to become locked inside the joint; operation was necessary to reduce it. In the second case reduction of the large fragment was achieved easily by simply dislocating the elbow, then reducing it, when the fragment settled in its bed (Figs. 8 and 9).

REFERENCES

ROBERTS, N. (1936): Fractures of External Condyle and Capitellum of Lower End of Humerus. Liverpool Medico-Chirurgical Journal, part 1, **44,** 1.

WATSON-JONES, R. (1943): Fractures and Joint Injuries. Third edition, **II,** 467. Edinburgh: E. & S. Livingstone.

THE SURGICAL TREATMENT OF DUPUYTREN'S CONTRACTURE

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This paper is based upon experience in the treatment of sixty-eight patients with Dupuytren's contracture who were subjected to operation. Of these, thirty-one had both hands operated upon, and thirty-seven each had one. In fifty-two of these ninety-nine hands the operation consisted of radical excision of the palmar fascia, which is generally accepted as the treatment of choice.

Excision of the palmar fascia is not necessarily an easy operation. The chief difficulties are those associated with severe flexion deformities of the fingers and with densely adherent skin. A simple standard technique will, however, overcome these.

TECHNIQUE OF RADICAL EXCISION OF THE PALMAR FASCIA

Skin incisions—In no case of Dupuytren's contracture is there any loss of skin. In the worst deformities the skin may have shrunk severely but, if the fascia is adequately excised,

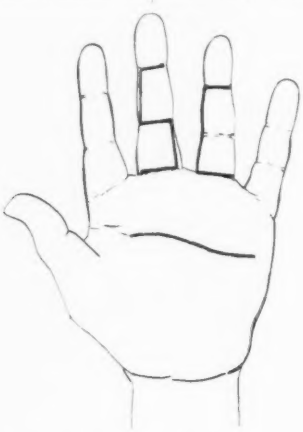

FIG. 1

Skin incisions for radical excision of the palmar fascia (after Bunnell and Gill).

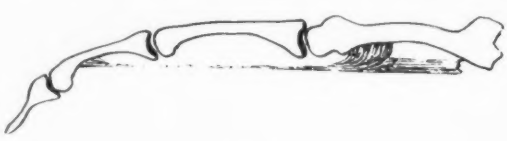

FIG. 2

Showing attachment of the palmar fascia to the metacarpal and to the middle phalanx of a finger.

FIG. 3

Attachment of thickened fascia to the extensor expansion and to the distal phalanx.

the skin will stretch in time. Recovery of normal extension is never prevented by contracture of skin, hence there is never any need for Z-incisions (Palmén 1932), V-Y-incisions (Skoog 1948), skin flaps (Seemen 1936) or skin grafting (Orbach 1934). There is, however, absolute necessity for properly planned incisions, for the gentle handling of skin and the avoidance of toothed forceps, towel clips, and other heavy instruments. Skin retraction must be performed only with fine skin hooks. The operation is performed under a tourniquet, which is removed before the wounds are closed.

The incisions employed are shown in Figure 1. The transverse palmar incision is that of Gill (1919). The long flap incision, illustrated here on the ring finger, is used in a finger in which the contracted fascia extends down one margin only. The base of the flap lies on the unaffected side. "Trap-door" flaps, as shown on the middle finger, are used when contracted bands run down both sides of the digit. The flaps are so designed as to give them the best possible blood supply.

Removal of the fascia—In all cases, however localised the lesion may appear, it is essential to remove *all* the fascia in the palm, however normal some may appear, *all* its vertical prolongations down the metacarpals, and all abnormal extensions into the fingers. To do less invites recurrence. The palmar fascia is attached not only to the metacarpals or phalanges, particularly the middle phalanges (Fig. 2), but also to the extensor expansions in the fingers (Fig. 3). The extensor expansions are not often involved in the pathological process but, when they are, a hyperextension deformity is produced at the distal joint (Fig. 4).

FIG. 4

The effect of contracture of the part of the fascia which reaches the extensor expansion. The terminal interphalangeal joint of this finger was completely dislocated. A finger so grossly deformed is better amputated.

It is not always appreciated that the vertical extensions of the fascia which pass down on either side of the tendons to become attached to the metacarpals (Fig. 5), if not removed at the time of excision of the palmar fascia, may later become involved in the pathological process in association with the extension of the fascia into the adjacent finger and will then form a point of purchase whereby a flexion contracture of the adjacent finger can be produced (Fig. 6).

Treatment of joint changes—In severe cases the fingers cannot immediately be fully extended on the operating table even after thorough removal of fascia. The residual deformity is due partly to plication of the anterior part of the capsules of the joints, particularly of the proximal interphalangeal joints, and partly to contracture of the capsule and of the collateral ligaments. Being attached to the middle phalanx, the shrunken fascia exerts its greatest pull just distal to the proximal joint. This is illustrated by the frequent formation of new bone at that level (Fig. 7), which new bone will disappear after removal of the fascia as the finger straightens.

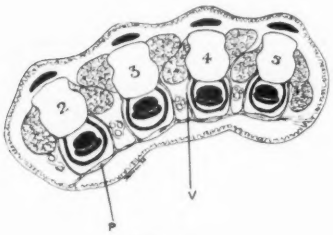

FIG. 5

Transverse section of the hand proximal to the necks of the metacarpals to show vertical extension of the palmar fascia gaining attachment to the metacarpals. P—Palmar fascia; V—Vertical extension.

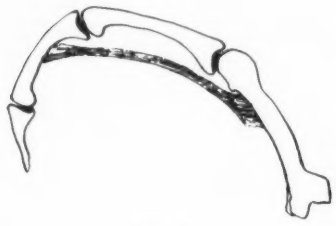

FIG. 6

Showing how, after removal of the palmar fascia, the vertical prolongation can produce a point of purchase for the development of a flexion contracture of the finger.

The mixture of plication and of contracture in the anterior capsule of the proximal interphalangeal joint is shown in Figure 8, but neither the capsule nor the articular surfaces show changes that are necessarily permanent.

Articular cartilage which, because of the flexed position, has had no contact with its fellow for a long period, loses some of its sheen and opacity, but histologically it remains potentially normal. There is no loss of substance and no more fibrillation than can be found in fingers of individuals of comparable age who have not suffered from Dupuytren's contracture. The joints, given time in which to overcome the contracture of the capsule, will usually develop a full or almost full range of movement. Capsulotomy is unnecessary. If it is done, the finger can certainly be fully extended on the

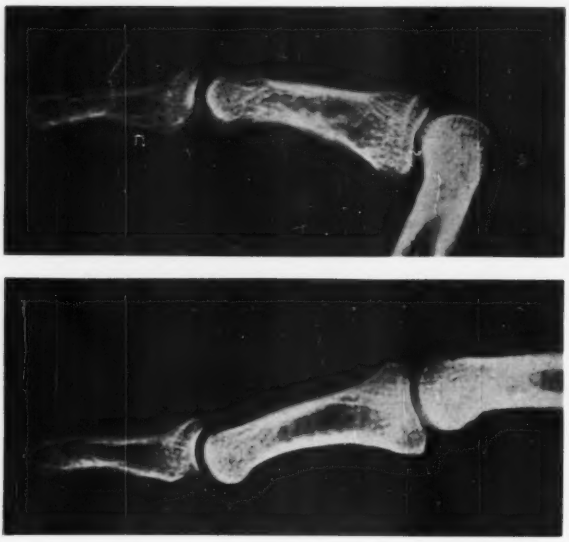

FIG. 7

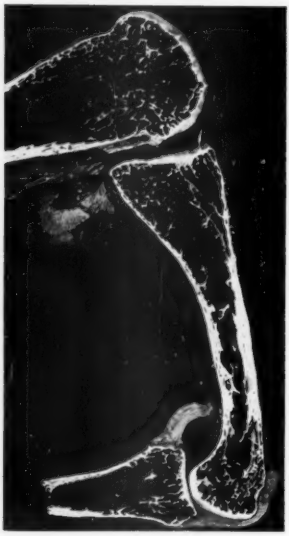

FIG. 8

Figure 7—New bone formed at the point of attachment of the fascia to the middle phalanx, and the disappearance of this bone after excision of the fascia and correction of the deformity. Figure 8—Plication and contracture of the anterior capsules of affected joints. These changes are seen clearly in the proximal interphalangeal joint, but they are also present in the metacarpo-phalangeal joint.

FIG. 9

After local excision of the fascia and skin, recurrence has occurred. The skin graft which was applied has contracted to produce a tension band between thumb and index finger. In cold weather this band split and produced a small, painful, chronic ulcer.

FIG. 10

The dressing and the plaster holding the fingers in the deformed position for fourteen days after radical excision of the fascia. The forearm is suspended within a roller towel for the first three days.

operating table, but, immediately the passive extending force is released, the finger springs back to its flexed position. This may be due to a relative weakness of the extensor mechanism, or to a potentially recoverable contracture of the flexor tendon. Whatever the reason, capsulotomy has certainly not increased the rate of recovery of extension in the joints in the cases in which it has been performed.

Wound closure and splintage—The tourniquet is removed and all bleeding stopped before the skin is closed. The skin is sutured with fine nylon. Mattress sutures are not to be used as they tend to cause skin necrosis. The skin is closed with the fingers in the deformed position, so that there is no tension on the suture line. Split-skin (Thiersch) grafting is not only

FIG. 11

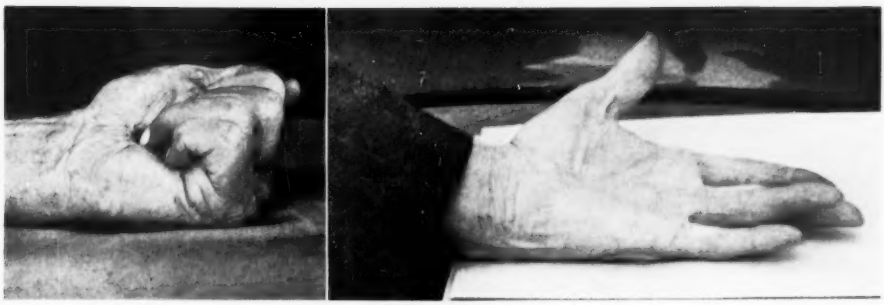

FIG. 12

Figure 11—Severe deformity from Dupuytren's contracture in a man of seventy-four. Figure 12—Range of movement eight months after radical excision of the fascia.

unnecessary, it is bad, for such grafts themselves contract and can produce tension bands such as are seen in between the thumb and the index (Fig. 9).

To avoid tension on the suture-line and tenting of the skin which predisposes to serous oozing and haematoma, a firm pressure-dressing of gauze, wool and a crepe bandage is applied to the palm, and the fingers and hand are splinted in flexion with a posterior plaster slab (Fig. 10). The arm is kept elevated in a suspended roller towel for three days, and then carried in a sling until the fourteenth day after operation. Active flexion of the fingers is begun the day after operation, but extension is prevented by the plaster splint until the fourteenth day, when the plaster and sutures are removed and active extension is begun.

The patient goes back to work as soon as the skin is soundly healed, although the deformity has only just begun to improve.

RESULTS OF EXCISION OF THE PALMAR FASCIA

In the fifty-two hands on which this operation was performed, it was possible fully to correct the deformity at the time of operation in twenty-five. All regained a full range of movement within six months. In the other twenty-seven, such immediate correction was not possible. All were much improved: twelve have regained a full range and the others are still improving, but, as improvement in this group continues for as long as two years, not all are yet at their best. Only eleven of them have been followed up for eighteen months or more. There have been no recurrences so far.

OTHER OPERATIONS

Of the remaining forty-seven hands, twenty-seven had had subcutaneous fasciotomy performed before they reached the author. Of these, twenty-five showed recurrence in less than eighteen months, and two were not traced.

In twenty other hands, local excisions of palmar fascia had produced four good results without recurrence. Four were not traced. Twelve showed recurrence within eighteen months.

The only operation of value, apart from radical excision of the fascia, is amputation. This is necessary in grotesque deformity (Fig. 4) but the deformity must be really grotesque, for very severe deformities will yield well to radical excision (Figs. 11 and 12).

I wish to express my thanks to the consultant orthopaedic surgeons of the London Hospital and of the Robert Jones and Agnes Hunt Orthopaedic Hospital for allowing me to treat their patients, and to Dr J. Ball for help with histology.

REFERENCES

DAVIS, J. S. (1919): Plastic Surgery: its Principles and Practice, p. 673. London: Henry Kimpton.

GILL, A. B. (1919): Dupuytren's Contracture, with a Description of a Method of Operation. Annals of Surgery, **70,** 221.

ORBACH, E. (1934): Die funktionelle Behandlung der Dupuytrenschen Fingerkontraktur. Archiv für Orthopädische und Unfall-Chirurgie, **34,** 572.

PALMÉN, A. J. (1932): Die Sägeplastik, eine unter anderen für Dupuytren'sche Fingerkontraktur und Syndaktylie geeignete Schnittführung. Zentralblatt für Chirurgie, **59,** 1,377.

SEEMEN, H. v. (1936): Zur Operation der Palmarkontraktur (Dupuytrensche Fingerkontraktur). Deutsche Zeitschrift für Chirurgie, **246,** 693.

SKOOG, T. (1948): Dupuytren's Contraction. Acta Chirurgica Scandinavica, **96,** Suppl. 139.

FIBROUS DYSPLASIA OF BONE WITH SKELETAL LIPOID GRANULOMATOSIS

Report of a Case with Necropsy

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This case is reported on account of the unusual combination of unilateral fibrous dysplasia of bone with lipoid granulomatosis. The disorder was also complicated by a neurological condition in which there were plaques of demyelinisation in the central nervous system, an association not so far reported.

CASE REPORT

The patient, aged fifty, had been healthy in childhood; at school she had been considered tall for her age but she ceased to grow after the age of fourteen. Menstruation started at the age of fifteen years and was normal. She married at nineteen, and had one son, who is healthy. She sustained no fractures. At the age of thirty-one years she complained of frontal headaches and vomiting; at that time the only abnormality then noted was " bossing " of the right frontal bone. When she was aged thirty-seven, radiography of the right femur, because of lumbar pain and pain and tenderness in the right thigh, suggested Paget's disease. At the age of forty-two, radiography of the right tibia because of pain and bowing, revealed changes there also. No biochemical abnormality was found. A biopsy of the femur showed " interstitial fibrosis." The neck was explored and the left upper parathyroid gland removed. Its histology was normal.

Fig. 1

Right tibia and fibula. Areas of radiotranslucence and sclerotic changes in the bone marrow, with irregular thinning of the cortex.

At the age of forty-eight years, she was admitted to the Royal Victoria Hospital, Belfast. Bossing of the right frontal bone had increased and there was proptosis of the right eye. Patches of light brown pigmentation were noted in the right temporal region and on the left side of the chin, and smaller patches were present on the back of the right hand and on the front of the legs below the knees. Radiographs of the skeleton (Fig. 1) showed that the following bones were affected: right frontal bone, base and vault of skull, right femur, right tibia and right fifth metacarpal bone. The serum calcium, inorganic serum phosphorus and alkaline phosphatase levels were repeatedly within normal limits. A tentative diagnosis of fibrous dysplasia of bone was made.

There was little change in the skeletal condition until her death, but when she was fifty the cutaneous pigmentation had disappeared, except from the face. She continued to be distressed by severe generalised pains.

The clinical picture was complicated from the age of forty-six onwards by a neurological condition diagnosed as disseminated sclerosis. This was brought to notice when she was admitted to hospital on account of unconsciousness, which lasted several hours and was followed by spastic paraplegia which persisted. Two years later the left arm showed paresis,

and she complained of transient blurring of vision although nothing was found objectively. Later the same year she suffered severe abdominal pain and vomiting. A right-sided Horner's syndrome appeared temporarily. There was stress incontinence of urine, with frequency and occasional precipitancy.

A year before her death the legs were contracted in flexion. General wasting of the left hand had developed, and all modalities of sensation were slightly involved in the left arm. Her general condition deteriorated steadily and she died in uraemia at the age of fifty.

Post-mortem-examination—The body, of moderate nutrition, showed deformities: a large bony swelling within the right frontal bone 6 centimetres in diameter, causing slight proptosis of the right eye; prominence of the right maxilla; bowing of the right tibia; and flexion contractures of both lower limbs. Slight brown pigmentation in two fairly well defined areas was seen over the right cheek and over the left side of the chin. *Viscera*—No lesions were seen in the thoracic abdominal viscera, except in the lungs which were oedematous and congested, the kidneys which showed marked changes of pyelonephritis, and the bladder which showed a chronic cystitis. *Brain and cord*—The meninges were not thickened and there was no evidence of cerebral swelling. After fixation, brain and cord were sectioned at 5-millimetre intervals. Within the brain no lesion was visible until the hind-brain was reached. In the vicinity of the roof of the fourth ventricle a firm grey plaque was seen within the cerebellum, situated on the left side and occupying the posterior half of the dentate nucleus and adjacent white matter. There were no other plaques in the cerebral hemispheres or in the brain stem. Within the cord, numerous plaques involved all columns at different levels, and were most marked in the cervical region.

Skeletal system—Right frontal bone: On section of the tumour the tissues consisted of extremely hard granular and bony material. Tiny spicules of bone could be seen enmeshed in the white granular material, which had one or two slightly darker areas scattered in it. Right tibia and right femur: On section the cortex was irregularly thinned. The medulla had been entirely replaced by firm white tissue, which contained numerous bony-hard spicules. Within it there were several cysts measuring 1 to 2 centimetres in diameter and containing bright green or brown mucoid material. Vertebral bodies: The lower thoracic and upper lumbar vertebral bodies were normal on section. The marrow was the usual deep red colour.

Histological examination. *Kidneys and bladder*—The pyelonephritis and cystitis were confirmed. *The remaining thoracic and abdominal viscera* presented normal appearances.

Brain and spinal cord—Sections from the brain and cord at different levels were stained by the usual techniques. The plaques seen macroscopically consisted of well demarcated areas of complete demyelinisation with preservation of ganglion cells and axis cylinders. These areas showed a marked gliosis. Fat was absent. Some of the plaques showed a peculiar predilection for the posterior horns, and at some levels were confined to these (Fig. 2). In the cervical region the plaques involved the anterior horns. Here there was some reduction in the number of ganglion cells; those remaining were normal. Gliosis was striking, and actively dividing astrocytes were present in the anterior horns. There was slight evidence of ascending and descending degeneration in the appropriate columns. No lipoid could be detected in the sections studied, in cord or brain. *Thyroid, adrenal, pituitary*—No changes were observed.

Bone—Numerous areas of affected and unaffected bone were studied. Variations of the same pathological process were seen in the tibia, the femur and the right frontal bone. The medulla of the bones was replaced by a peculiar tissue which in many fields consisted of masses of foam cells intermingling with relatively cellular fibrous tissue. These foam cells had a reticulated cytoplasm and a small dark nucleus, usually placed eccentrically (Fig. 3). Occasional giant forms with several nuclei were seen. Scattered amongst this tissue were groups of eosinophils and lymphocytes. Such fields merged gradually into others where intervening strands of collagen were more prominent, fibrocytic nuclei were scarcer and narrower, and foam cells were no longer identifiable (Fig. 4). But in these areas lipoid was relatively abundant

in frozen sections, and was mostly extracellular (Fig. 5). It was identified here, and in sites of foam cell formation as a mixture of cholesterol and cholesterol esters by the Nile blue sulphate, Liebermann-Burchard and digitonine reactions. In some fields, new bone

FIG. 2

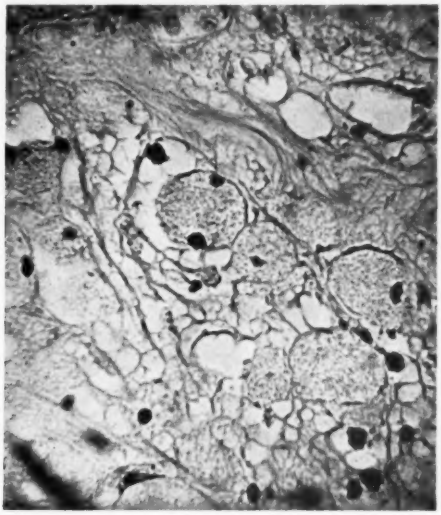

FIG. 3

Figure 2— Spinal cord. Note the well defined plaques of demyelinisation, with predilection for the posterior horns (Spielmeyer × 8). Figure 3—Bone medulla, showing foam cells and connective tissue (H. and E. × 750).

FIG. 4

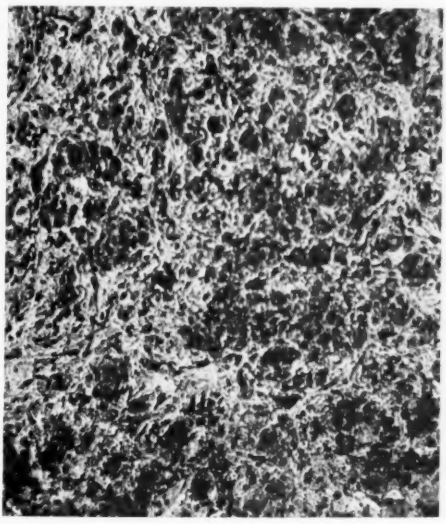

FIG. 5

Figure 4—Section from bone, showing loose collagenous fibrous tissue, with metaplasia to fibre bone. Foam cells cannot be seen in this area (H. and E. × 110). Figure 5—Numerous sudanophilic deposits in an area similar to that seen in Figure 4 (Scharlach R. × 110).

formation was entirely lacking. It was more common to find bony trabeculae, however, both where foam cells were obvious and in the large areas of marrow fibrosis. These trabeculae were studded with tiny globules of calcium salts, or were more homogeneous. In either case

the interweaving collagen fibres on which the bone was formed could be made out (Fig. 4). Few osteoblasts lined these trabeculae. Occasional trabeculae of lamellar bone could be seen, usually near the cortical compact bone, and were interpreted as surviving trabeculae. In only one or two places was there osteoclastic activity with erosion of lamellar bone trabeculae. There were no giant-cell tumours. Sometimes osteoid seams were present along the margins of the fibre bone trabeculae, and in some areas, again near the cortex, osteoid was deposited by itself in small adjacent pavement-like islands. Foam-cell formation, in sections stained with haematoxylin and eosin, was present in about half of the affected marrow. In the fibrotic marrow calcium salts were irregularly distributed in the form of fine granules and clumps. They were most noticeable in the walls of the large cysts, which contained a homogeneous acidophilic colloid substance. The cysts were bounded by a narrow rim of compressed fibrous tissue in some instances, and in others merged gradually into the surrounding fibrous tissue. They were ascribed to focal degeneration. No foci of recent haemorrhage were encountered, although a few granules of haemosiderin were seen in one area. Vessels were sparse, and were thin-walled sinusoidal capillaries. They were more frequently seen in the foam-cell granulomatous areas.

The bone cortex was altered by the granulomatous process in the medulla. It was narrowed in many places, and its Haversian canals were widely dilated. They contained either normal fatty marrow or were filled by a fibrous tissue with a tendency to whorl and in which the fibrocytic nuclei were plumper than anywhere else. This tissue was practically free from foam cells. No islands of cartilage formation were encountered.

DISCUSSION

This case shows the characteristics of fibrous dysplasia of bone (Lichtenstein and Jaffe 1942). Pigmentation was present, but not sexual precocity, so that it cannot be labelled the rare Albright's syndrome (Albright *et al.* 1937), although there was possibly evidence of accelerated skeletal development (Önne 1951). The disorder is generally considered developmental, because of the predominantly unilateral distribution of the bony lesions, the occasional pigmentation, the usual early age of onset and the not uncommon association with congenital anomalies. Ten cases with such an association have been discovered in the literature by Vines (1952) and in addition a case with congenital cataracts has been reported by Meyersohn and Grek (1951). Transmission to a daughter has been reported once (Hibbs and Rush 1952). Endocrine disturbance, when present, is considered to be secondary, perhaps to involvement of the pituitary fossa.

This patient did not show any sign of bony disease until the age of thirty-one, when a bossing of the right frontal bone was noted, but the age of onset cannot be ascertained because often the affection is symptomless for years and may be discovered accidentally.

The histological findings in the skeleton were in many respects identical with those of fibrous dysplasia. In affected areas of bone only, there was thinning of the cortex, with erosion, replacement of the cancellous marrow by a proliferating fibrous tissue, which formed numerous trabeculae of fibre bone and in which cysts containing gelatinous material were found. No islands of cartilage, such as are occasionally present, were discovered. The one uncommon feature was the ubiquitous presence of cholesterol and its esters within large sheets of well formed foam cells, or in the interstices of the mature or old fibrous tissue where it could only be detected on special staining. Foam cells have been noted many times in this disease, but mostly in small islands. Dockerty *et al.* (1945) stated that they never occur in the abundance in which they may be present in " xanthoma." Russell and Chandler (1950) considered that they are of no significance. Jaffe (1945), Pritchard (1951) and others held that they represent a reaction to haemorrhage and degeneration.

The explanation of the presence of the lipoid, extracellular and intracellular, in our case is not easy. It is obviously not the result of a focal reaction to haemorrhage or

degeneration. Dominating the histological picture in all areas studied, it can scarcely be a mere secondary infiltration. The histological picture suggests the reverse: there is a transition from areas where the fibrous tissue is young and active and foam cells are abundant, to other areas of relatively acellular collagenous fibrous tissue. Here foam cells are no longer found but lipoid is present in the interstices of the tissue, where it can be detected only by special staining. It becomes apparent that we are dealing with a condition histologically akin to lipoid granulomatosis of bone, the osseous form of Hand-Schüller-Christian disease.

Christian considered the syndrome of defects of membranous bones, exophthalmos and diabetes insipidus to be due to dyspituitarism, but later authors such as Thompson, Keegan and Dunn (1925) ascribed the endocrine features of the disease to pressure by altered bone on the hypothalamic region. There is a parallel here with Albright's syndrome: in cases showing endocrine disturbance there is usually a marked change in the bones of the skull base (Önne 1951). The present tendency is to consider the bony changes in Hand-Schüller-Christian disease to be paramount, and to consist of a granulomatous process involving the reticulo-endothelial system. There is a proliferation of histiocytic elements, with infiltration by lymphocytes and eosinophil cells. In a later phase, these histiocytes develop into foam cells containing cholesterol and its esters, and in the final stages there is gradual disappearance of foam cells with development of fibrous tissue. This was seen, for example, in the first case coming to necropsy (Thompson *et al.* 1925). The arguments that the condition is not a primary disturbance in cholesterol metabolism, as suggested by Rowland (1928), are now well known (Snapper 1943, Jaffe and Lichtenstein 1944, Wallgren 1940) and need not be repeated. In our case the fibrous tissue showed distinct metaplasia to irregular, poorly formed fibre-bone trabeculae, a process which has been stated not to occur in lipoid granulomatosis. According to Robb-Smith (1942), new bone is rare in Hand-Schüller-Christian disease, and when found is lamellar bone. It must be remembered that many patients with Hand-Schüller-Christian disease die at an early age, and there may not be time for such a process, which represents an attempt at healing of the lesion, to occur. It has however been described in older patients. In one example, a man aged fifty, coming to necropsy and minutely described by Heine (1935), fibre-bone formation as well as lamellar bone was a prominent feature in the oldest lesions. New bone, lamellar and fibre, occurred in both of Chester's cases (1930). Therefore, metaplasia of the fibrous tissue to bone, fibrous and lamellar, is quite consistent with lipoid granulomatosis.

The histological features of this case are thus in keeping with the diagnosis of skeletal lipoid granulomatosis, and yet it presents the cutaneous and skeletal features of fibrous dysplasia with cutaneous pigmentation.

The existence of fibrous dysplasia of bones and the rarer, complete Albright's syndrome as a separate entity cannot be questioned. A very large number of cases exists whose pathological diagnosis rests on adequate biopsy material, even though detailed necropsy reports are scarce (Sternberg and Joseph 1942, Uehlinger 1940, Jervis and Schein 1951). In most cases foam cells have been seen only in small islands or have not been found, even on the rare occasions when looked for by specific staining methods (Valls *et al.* 1950). Snapper (1943) was formerly of the opinion that such cases represent a burnt-out lipoid granulomatosis, but the evidence that fibrous dysplasia of bone is a dysplasia separates the two conditions. Nevertheless there does appear to be a small group of cases of fibrous dysplasia in which foam-cell formation is an integral part of the disease process, among them Snapper's two cases (1949), and that reported by Sánchez-Lucas and Castells Freixā (1949). The latter authors viewed their case as a combination of fibrous dysplasia and xanthomatosis. We consider that it is only possible to say at present that a small proportion of cases of fibrous dysplasia exists in which the skeletal lesion takes the form of a lipoid granulomatosis. Further studies of necropsy and biopsy material, bearing in mind that lipoid may be missed in haemotoxylin and eosin sections, may increase this proportion, and a closer relationship may

be discovered between lipoid granulomatosis on the one hand and fibrous dysplasia of bones on the other. The diagnosis of fibrous dysplasia has perhaps been too freely entertained, and many cases of the monostotic form, as Schlumberger (1946) observed, should be ascribed to an atypical reaction to trauma.

The neurological disorder which complicated our case is of some interest and adds support, however slight, to the concept of lipoid granulomatosis. The morbid anatomical picture, as it stands at present, is indistinguishable from disseminated sclerosis, and in fact the case is similar to those described in the older patients, in which anterior horn cell destruction was not infrequent (Friedman and Davison 1945). However, in an undoubted case of Hand-Schüller-Christian disease, Heine (1935) discovered numerous minute foci of demyelinisation and gliosis, with conservation of axis cylinders and nerve cells, scattered throughout the brain. He considered that they might well represent the healed stage of lipoid granulomata in the brain. Such had been seen in another case reported by Chiari (1931) where actual foam cell deposits were found in brain substance as well as plaques of demyelinisation. Plaques were also seen in Davison's case (1933), and lipoid infiltrations in the neuraxis were described by van Bogaert, Scherer and Epstein (1937), Guillain, Bertrand and Godet-Guillain (1942), and Weidman and Schaffer (1937). Thus lipoid or lipogranulomatous infiltrates may occur within the neuraxis and have apparently given rise to plaques of demyelinisation. Such a derivation for the plaques in our case is an interesting probability, though far from proven.

No such focal demyelinisation has been described in fibrous dysplasia of bone. In the case with cerebral symptoms reported by Jervis and Schein (1951) the findings were of an entirely different character, suggesting a developmental origin. Giant ganglion cells were found, and a general deficiency in nerve cells in grey matter without any glial reaction. Although there were no giant glial cells or glial nodes, the condition was held to be akin to tuberose sclerosis.

SUMMARY

1. A case of fibrous dysplasia in a woman aged fifty, with unilateral skeletal lesions, cutaneous pigmentation and possibly accelerated skeletal growth, is described.

2. At necropsy, the bony changes were found to be complicated by many of the changes of lipoid granulomatosis. Disseminated plaques of demyelinisation were found in the central nervous system.

3. The implications of the case are discussed.

We would like to express our indebtedness to Professor J. H. Biggart, for his encouragement and helpful criticism; to Dr R. S. Allison, who was in charge of the patient, for his interest; to Dr Porter for the radiograph; and to Mr D. Mehaffey, A.R.P.S., for the photographs.

REFERENCES

ALBRIGHT, F., BUTLER, A. M., HAMPTON, A. O., and SMITH, P. (1937): Syndrome Characterized by Osteitis Fibrosa Disseminata, Areas of Pigmentation and Endocrine Dysfunction, with Precocious Puberty in Females. New England Journal of Medicine, **216,** 727.

BOGAERT, L. van, SCHERER, H. J., and EPSTEIN, E. (1937): Une Forme Cérébrale de la Cholestérinose Généralisée: Type Particulier de Lipidose à Cholestérine. Paris: Masson & Cie.

CHESTER, W. (1930): Über Lipoidgranulomatose. Virchow's Archiv für Pathologische Anatomie und Physiologie und für Klinische Medizin, **279,** 561.

CHIARI, H. (1931): Die generalisierte Xanthomatose vom Typus Schüller-Christian. Ergebnisse der Allgemeinen Pathologie und Pathologischen Anatomie des Menschen und der Tiere, **24,** 396.

DAVISON, C. (1933): Xanthomatosis and the Central Nervous System: (Schüller-Christian Syndrome). Archives of Neurology and Psychiatry, **30, 75.**

DOCKERTY, M. B., GHORMLEY, R. K., KENNEDY, R. L. J., and PUGH, D. G. (1945): Albright's Syndrome. (Polyostotic Fibrous Dysplasia with Cutaneous Pigmentation in Both Sexes and Gonadal Dysfunction in Females.) Archives of Internal Medicine, **75,** 357.

FRIEDMAN, A. P., and DAVISON, C. (1945): Multiple Sclerosis with Late Onset of Symptoms. Archives of Neurology and Psychiatry, **54,** 348.

GUILLAIN, G., BERTRAND, I., and GODET-GUILLAIN (1942): Étude Anatomo-clinique d'un Cas de Cholestérinose Cérébrale. Revue Neurologique, **74,** 249.

HEINE, J. (1935): Beitrag zur Schüller-Christian'schen Krankheit. Beiträge zur Pathologischen Anatomie und zur Allgemeinen Pathologie, **94,** 412.

HIBBS, R. E., and RUSH, H. P. (1952): Albright's Syndrome. Annals of Internal Medicine, **37,** 587.

JAFFE, H. L. (1945): Fibrous Dysplasia of Bone. A Disease Entity and Specifically not an Expression of Neurofibromatosis. Journal of the Mount Sinai Hospital, **12,** 364.

JAFFE, H. L., and LICHTENSTEIN, L. (1944): Eosinophilic Granuloma of Bone. A Condition Affecting One, Several or Many Bones, but Apparently Limited to the Skeleton, and Representing the Mildest Clinical Expression of the Peculiar Inflammatory Histiocytosis also Underlying Letterer-Siwe Disease and Schüller-Christian Disease. Archives of Pathology, **37,** 99.

JERVIS, G. A., and SCHEIN, H. (1951): Polyostotic Fibrous Dysplasia (Albright's Syndrome). Report of a Case Showing Central Nervous System Changes. Archives of Pathology, **51,** 640.

LICHTENSTEIN, L., and JAFFE, H. L. (1942): Fibrous Dysplasia of Bone. A Condition Affecting One, Several or Many Bones, the Graver Cases of which may Present Abnormal Pigmentation of Skin, Premature Sexual Development, Hyperthyroidism or still other Extra-skeletal Abnormalities. Archives of Pathology, **33,** 777.

MEYERSOHN, S., and GREK, I. J. (1951): Polyostotic Fibrous Dysplasia. British Journal of Radiology, **24,** 629.

ÖNNE, L. (1951): On Fibrous Dysplasia of Bone. Acta Chirurgica Scandinavica, **101,** 318.

PRITCHARD, J. E. (1951): Fibrous Dysplasia of Bones. American Journal of the Medical Sciences, **222,** 313.

ROBB-SMITH, A. H. T. (1942): Contribution to FALCONER, M. A., and COPE, C. L. (1942): Fibrous Dysplasia of Bone with Endocrine Disorders and Cutaneous Pigmentation. (Albright's Disease.) Quarterly Journal of Medicine, **N.S. 11,** 121.

ROWLAND, R. S. (1928): Xanthomatosis and the Reticulo-Endothelial System. Archives of Internal Medicine, **42,** 611.

RUSSELL, L. W., and CHANDLER, F. A. (1950): Fibrous Dysplasia of Bone. Journal of Bone and Joint Surgery, **32–A,** 323.

SANCHEZ-LUCAS, J. G., and CASTELLS FREIXÁ, M. (1949): Sindrome de Albright. Cirugia del Aparato Locomotor, **6,** 45.

SCHLUMBERGER, H. G. (1946): Fibrous Dysplasia of Single Bones (Monostotic Fibrous Dysplasia). Military Surgeon, **99,** 504.

SNAPPER, I. (1943): Medical Clinics on Bone Diseases: A Text and Atlas. New York: Interscience Publishers Inc.

SNAPPER, I. (1949): Medical Clinics on Bone Diseases: A Text and Atlas. Second edition. London: Interscience Publishers Ltd.

STERNBERG, W. H., and JOSEPH, V. (1942): Osteodystrophia Fibrosa Combined with Precocious Puberty and Exophthalmic Goiter. Pathologic Report of a Case. American Journal of Diseases of Children, **63,** 748.

THOMPSON, C. Q., KEEGAN, J. J., and DUNN, A. D. (1925): Defects of Membranous Bones, Exophthalmos and Diabetes Insipidus: Report of a Case with Necropsy. Archives of Internal Medicine, **36,** 650.

UELINGER, E. (1940): Osteofibrosis deformans juvenilis (Polyostotische fibröse Dysplasie Jaffe-Lichtenstein). Virchow's Archiv für Pathologische Anatomie und Physiologie und für Klinische Medizin, **306,** 255.

VALLS, J., POLAK, M., and SCHAJOWICZ, F. (1950): Fibrous Dysplasia of Bone. Journal of Bone and Joint Surgery, **32–A,** 311.

VINES, R. H. (1952): Polyostotic Fibrous Dysplasia. Archives of Disease in Childhood, **27,** 351.

WALLGREN, A. (1940): Systemic Reticuloendothelial Granuloma, Nonlipoid Reticuloendotheliosis and Schüller-Christian Disease. American Journal of Diseases of Children, **60,** 471.

WEIDMAN, F. D., and SCHAFFER, H. W. (1937): Xanthoma of the Skin and Larynx. Associated with Carcinoma of the Stomach and a Regressive Xanthoma of the Pons. Archives of Dermatology and Syphilology, **35,** 767.

A LOCKED INDEX FINGER

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From the Orthopaedic Department, Dunedin Hospital

Injury to the ligaments and capsule of the metacarpo-phalangeal joints of the fingers is common. The following case, in which the metacarpo-phalangeal joint of the index finger was locked in a manner not previously described, was considered worth recording.

CASE REPORT

A thirty-one years old butcher injured his hand while attempting to catch a lamb: he grasped a leg with each hand but the lamb struggled and he lost his grip with the left hand. The leg slipped between the index and middle fingers, forcing the index into flexion and ulnar deviation. He felt a painful " snap " on the radial aspect of the metacarpo-phalangeal joint and was unable to straighten the finger.

When he was first seen a week after injury the left index finger was held in a position of 40 degrees flexion at the metacarpo-phalangeal joint (Fig. 1). Flexion of the finger was

FIG. 1
The index finger in the locked position.

full and painless. Attempts to straighten the finger actively or passively were prevented by a rigid resistance in the matacarpo-phalangeal joint which produced slight discomfort. The joint was stable. Radiographs were normal. It was decided to explore the joint.

Findings at operation—Preliminary manipulation under anaesthesia showed the block to extension to be as rigid as before. The joint was opened on its ventral and radial aspects. A tear was found in the capsule, the proximal part of which had retracted and rolled up into a tight band which was caught round the metacarpal head (Fig. 2). When attempts were made to straighten the finger the band became tighter and prevented full extension of the

metacarpo-phalangeal joint. With the joint flexed the tight band could be pulled out from its trapped position and the joint easily straightened. By tucking it back round the head of the metacarpal the rigid locking was reproduced. The defect in the capsule was closed by two catgut sutures and the finger was immobilised in plaster for three weeks. Five weeks after operation function was full and the patient returned to work.

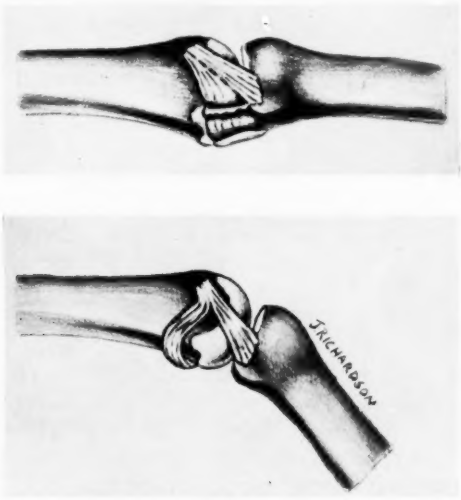

FIG. 2

Showing the tear between the two parts of the collateral ligament. The proximal part had rolled upon itself and was caught round the head of the metacarpal.

DISCUSSION

The lateral and medial ligaments of the metacarpo-phalangeal joints consist of two parts. The dorsal part is rounded and cord-like and is attached eccentrically to the metacarpal head. It is slack in extension and taut in flexion; hence the fingers cannot be spread unless the hand is open. The ventral part is thinner and fan-like and extends across the front of the joint as the palmar or volar accessory ligament to become continuous with its fellow of the opposite side. It may be thickened on its ventral aspect to form a fibrocartilaginous plate.

In this case the tear was between the cord and the fan as shown by the dotted line in Figure 2. The fibrocartilaginous plate could not be demonstrated. The fan and the palmar ligament appeared as a thickened band rolled upon itself in the displaced position. When freed and stretched across the front of the joint the thin flat band of the fan could be demonstrated. The position was such that manipulation could not have unlocked the joint.

I am indebted to Mrs J. Richardson for the drawings, and to Miss D. Marshall for the clinical photograph.

A LATERAL INTERMUSCULAR APPROACH TO THE HIP JOINT FOR REPLACEMENT OF THE FEMORAL HEAD BY A PROSTHESIS

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From the Orthopaedic Department of the General Infirmary at Leeds

The purpose of this communication is to present a simple method of exposure of the hip joint for the insertion of an artificial femoral head in patients who have fracture of the femoral neck or osteoarthritis of the hip, many of whom are old or feeble.

For fractures of the femoral neck, the prevalent view seems to be that operation should always be undertaken unless the patient is moribund or suffering from advanced senile mental change (Williams and McLean 1952). Hitherto it has been thought that a rapid extra-articular nailing operation disturbs the patient least. Replacement of the femoral head by a prosthesis, through the exposure described here, is considered to be no more dangerous than an extra-articular nailing operation.

In the treatment of osteoarthritis of the hip, many patients are over seventy years of age and the natural tendency is to avoid the risk of surgery. Replacement of the femoral head by way of this lateral intermuscular approach proves not to be a severe ordeal.

Essentially, the surgical approach advocated here is a modification of that described by Watson-Jones (1936), in which neither muscle nor tendon is divided.

THE OPERATION

The patient is placed in a lateral position with the affected hip uppermost. Rests are used to stabilise the patient by placing one before the abdomen, one behind the lower lumbar region and one behind the thorax. The surgeon stands behind the patient.

The skin incision is angled; its lower limit lies over the anterior border of the upper six inches of the femoral shaft and the upper limit passes upwards and backwards towards a point on the iliac crest three inches in front of the posterior superior iliac spine (Fig. 1). It is unnecessary to undercut the skin. The ilio-tibial tract and gluteal aponeurosis are incised in the same line as the skin incision, along the antero-lateral aspect of the shaft, and upwards and backwards along the upper border of the gluteus maximus (Fig. 2). The posterior flap of fascia lata is reflected backwards to expose the insertions of the glutei on the trochanter (Fig. 3). With an assistant holding the foot so that the thigh is in lateral rotation the anterior flap is reflected forwards on a deep plane to expose, successively, the anterior surface of the vastus lateralis, the capsule of the joint, the surface of the gluteus medius, and the division between the anterior borders of the glutei and the tensor fasciae latae almost up to the iliac crest (Fig. 4). The dissection is made close to the capsule, the pad of fat containing branches of the lateral circumflex vessels being held forwards by a retractor. The nerve to tensor fasciae latae runs forwards from the glutei deeply, close to the ilium, about one inch from the crest.

The exposure of the anterior capsule is then completed medially, again close to the capsular fibres, until the rim of the acetabulum is reached. This limit is determined by one, or a combination, of three ways. If the fibres of iliacus are exposed in the dissection, the lateral border is retracted anteriorly and medially. If the limb is gently rocked, the margin of the acetabulum can be palpated as a fixed structure in contrast to the moving head. If the capsule is incised along the middle of the neck the labrum is reached (Fig. 4).

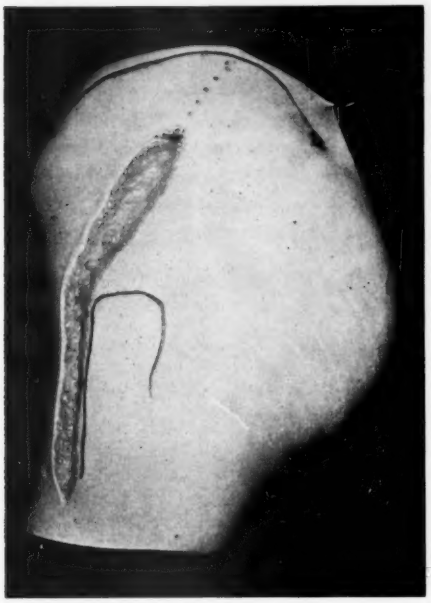

FIG. 1

FIG. 2

Figure 1—The skin incision. Its upper limit is three inches in front of the posterior superior spine of the ilium. Figure 2—The fascia lata has been incised: the gluteus maximus has fallen backwards and the tensor fasciae latae forwards, exposing the gluteus medius, the greater trochanter and vastus lateralis.

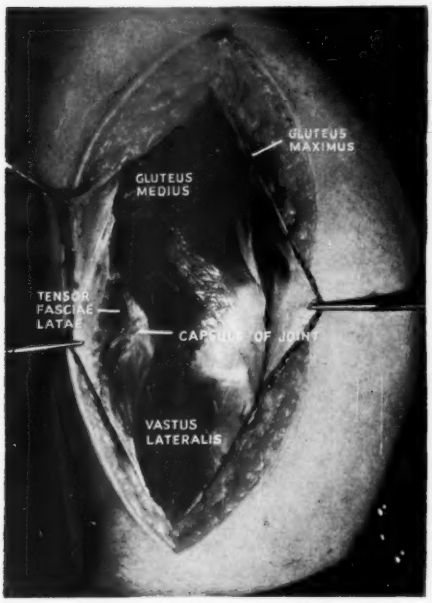

FIG. 3

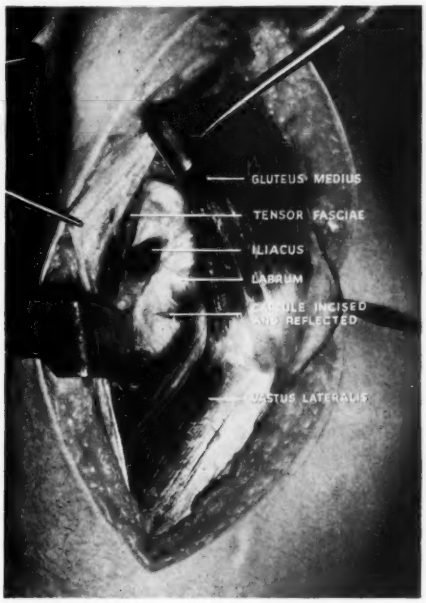

FIG. 4

Figure 3—Further reflection of gluteus maximus backwards and tensor fasciae latae forwards uncovers the whole width of gluteus medius and reveals the capsule of the hip joint. Figure 4—The capsule has been incised and reflected, to reveal the labrum.

The capsule is either excised or opened by an H-shaped incision and retracted (Fig. 5). The strong superior part of the capsule is divided as it runs downwards and laterally deep to the anterior border of gluteus minimus.

The hip is dislocated by the following manoeuvre. The knee is flexed with the hip maintained in extension. The femur is abducted, and then rotated laterally so that the foot is brought to the opposite knee. In this way lateral rotation is obtained without unduly stretching the glutei. Rotation is maintained while the foot of one limb is moved down the shin of the other, so that abduction is reduced. The last movements must be performed carefully so that the head, or fractured neck, emerges in front of the glutei without damaging them (Fig. 6).

If the neck of the femur is broken, the femoral head is removed from the acetabulum.

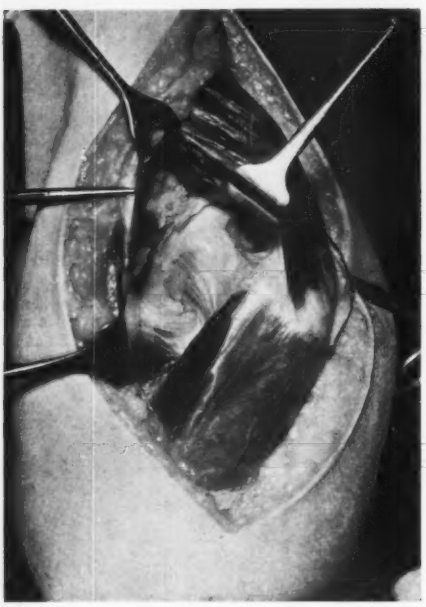

FIG. 5

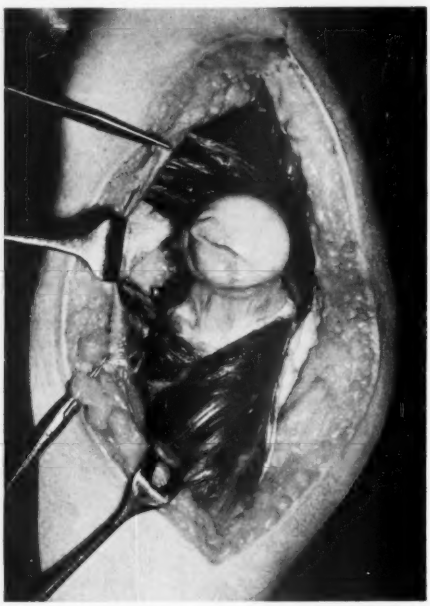

FIG. 6

Figure 5—The labrum has been excised in preparation for dislocating the joint. Figure 6—The joint dislocated and the femoral head turned forwards.

The prosthesis is fitted according to one of the usual techniques. The hip is reduced by traction and medial rotation with the hip and knee extended.

The wound is closed in two layers with interrupted sutures for the fascia lata and gluteal aponeurosis. Usually it is unnecessary to employ any splint.

Special points in the operation—It is important to secure the patient in the correct position on the table before beginning the operation. This facilitates accurate placing of the incision and dislocation of the hip.

Exposure of the neck of the femur between tensor fasciae latae and the glutei has been described for open reduction of fractures (Watson-Jones 1936, Hudson and Bartels 1939). In that operation it is not necessary to dislocate the hip and the incision through the skin and fascia is accordingly made in the plane of separation of the muscles, between the greater trochanter and the anterior superior iliac spine. With such an incision, the posterior flap of fascia lata tightens on lateral rotation of the hip and prevents easy dislocation of the joint.

The incision described by Gibson (1950) permits easier rotation of the femur, and after dislocation the head presents in the centre of the wound. The method of dislocating the hip described by Gibson involves flexion of the joint, and it has been found that this movement causes excessive tension on the intact glutei. In dislocating the hip by the intermuscular method, flexion is therefore avoided and it is at this stage that the help of the anaesthetist may be sought to obtain temporary muscle relaxation. Despite these precautions a few of the muscle fibres of the glutei may be torn. This is found not to impair the final result.

DISCUSSION

The intermuscular approach described is basically that of Watson-Jones (1936), the difference being that the upper part of the incision is inclined backwards instead of forwards and that the head of the femur is dislocated. This approach was adopted for the replacement of the femoral head after a trial of that described by Gibson (1950), in which the insertions of the glutei are severed near their attachments to the greater trochanter and turned up to expose the hip. Gibson's approach gives an excellent exposure but at the conclusion of the operation the glutei, which form an important group of hip stabilisers, have to be repaired. The tendon repair involves the disadvantage of delay to await healing. There is also the risk of permanent muscle weakness and possibly failure of union: it has been found that the wide postero-lateral exposure tends to cause a Trendelenberg type of limp (Nissen 1952). For this reason some surgeons prefer the short vertical approach of Hueter, advocated by Judet and Judet (1950), which, like the lateral intermuscular approach, has the advantage of dividing neither muscle nor tendon. We find that the lateral intermuscular approach gives a better exposure than the short anterior one of Hueter.

In the use of the artificial femoral head for osteoarthritis of the hip many surgeons consider that it is usually unnecessary to remove osteophytes from the rim of the acetabulum. If unexpected difficulty is encountered in delivering the head of the femur because of osteophytic formation, or if it is found at operation that osteophytes are likely to limit movement, then those osteophytes that are accessible from the front may be removed. If exceptional difficulty were to be found, it would be a simple matter to extend the lateral intermuscular approach by division of the gluteal tendons (Gibson 1950) or by separation of their bony insertion (Postel 1951).

Operation by the lateral intermuscular approach causes little or no shock. Blood loss is negligible: no large vessel is visible, and usually haemostats need to be applied to subcutaneous vessels only. The time taken for the operation is short, a matter of great importance to old people. The supposition that the manoeuvre of dislocating the hip is attended by considerable shock has been disproved by pulse and blood-pressure records during operation.

The after-care of a patient with a fracture of the femoral neck which has been operated on through the lateral intermuscular approach is simple. Spontaneous dislocation of the hip is unlikely because forced lateral rotation would be required to produce it. The patient may be allowed to sit out of bed the day after operation, and hip movements are started about ten days later, when the wound is healed. At that time, or within a few days, the patient begins to walk with crutches. A good range of hip movement is usually regained rapidly. After operation for osteoarthritis, remedial treatment must be more intensive to restore mobility and to redevelop the abductors and extensors of the hip, because the muscles are weak from disuse. But walking with crutches need not be delayed on this account.

We believe that replacement of the femoral head, through the lateral intermuscular approach, is a sound primary operation for fracture of the femoral neck in elderly or unfit patients. The operation is no more severe than that of nailing. So far we have used the lateral intermuscular approach in more than thirty operations for osteoarthritis or fracture of the femoral neck, and in four operations for open reduction of congenitally dislocated hips.

SUMMARY

1. A lateral intermuscular approach to the hip joint is described for replacement of the head of the femur by a prosthesis.

2. Advantages claimed for it are that it is attended by little or no shock, because the operation is rapid and relatively bloodless; that adequate exposure can be gained without dividing muscle or tendon; and that muscle function is unimpaired and so walking can be allowed early. The exposure is easily extended if unexpected difficulty is encountered.

3. Prosthetic replacement of the femoral head through this incision is advocated as a primary measure for elderly or unfit patients with fractured femoral neck.

We wish to thank Mr R. Broomhead, Mr A. B. Pain and Mr J. M. P. Clark for their encouragement and kindly criticism, and for permission to operate on some of the patients. Our thanks are due to Mr A. Pegg of the Department of Photography of the University of Leeds.

REFERENCES

GIBSON, A. (1950): Posterior Exposure of the Hip Joint. Journal of Bone and Joint Surgery, **32–B,** 183.

HUDSON, O. C., and BARTELS, W. P. (1939): Open Fixation of Intracapsular Fracture of the Femur: An Improved Technique. Journal of Bone and Jount Surgery, **21,** 1,001.

JUDET, J., and JUDET, R. (1950): The Use of an Artificial Femoral Head for Arthroplasty of the Hip Joint. Journal of Bone and Joint Surgery, **32–B,** 166.

NISSEN, K. I. (1952): The Judet Arthroplasty of the Hip via Gibson's Lateral Approach. Postgraduate Medical Journal, **28,** 412.

POSTEL, M. (1951): Arthroplasties de la Hanche. Paris: Encyclopédie Médico-Chirurgicale.

WATSON-JONES, R. (1936): Fractures of the Neck of the Femur. British Journal of Surgery, **23,** 787.

WILLIAMS, D. O., and MCLEAN, E. K. (1952): The Treatment of Recent Transcervical Fractures of Femur. British Medical Journal, **1,** 580.

AN UNUSUAL LIPOID RETICULOSIS OF BONE

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The patient described in this paper presented an affection of the skeleton which has not, so far as we are aware, been recorded previously.

CASE REPORT

A Muganda boy aged eight years was admitted to Mulago Hospital, Kampala, with a painful swelling of his left foot and leg. Ten months previously the distal phalanx of his left great toe had been amputated elsewhere for some septic condition. Two months later the left foot became painful and swollen and the swelling gradually spread up towards the knee.

On examination the foot and the leg as far as the knee were diffusely swollen (Fig. 1). The overlying skin was normal though stretched: there was no oedema and no open or healed

FIG. 1
Photograph showing the diffuse enlargement of the leg and foot.

FIG. 2
Antero-posterior and lateral radiographs of the left tibia and fibula.

sinus. There was a slight rise in temperature over the affected area but no tenderness. Movement of the ankle joint was only slightly impaired. The affected leg was one inch longer than its fellow, measured from the knee to the ankle. There was no enlargement of the spleen. The patient was afebrile while under observation.

Investigations—White cell count 10,200 per cubic millimetre (neutrophils 56 per cent; lymphocytes 36 per cent; eosinophils 4 per cent; monocytes 4 per cent). Red cell count 4,240,000 per cubic millimetre. Haemoglobin 68 per cent (9·2 grammes per cent). Colour index 0·80. Examination of the urine showed no Bence-Jones proteose. The blood calcium was 9·8 milligrams per cent on two occasions at ten weeks interval. Blood phosphorus was 5 milligrams per cent and 4·5 milligrams per cent on two occasions at ten weeks interval.

Blood cholesterol was 196 milligrams per cent. The Kahn reaction was doubtfully positive. *Radiographic examination* (Dr J. Scott Brown)—The whole skeleton was examined. Lesions were found only in the left foot, the left tibia and fibula, and the right humerus. The affected

FIG. 3

FIG. 4

Figure 3—Left knee, showing early involvement of the lower femoral epiphysis. Figure 4—Antero-posterior radiograph of left foot. The right foot was normal.

FIG. 5

Lateral radiograph of left foot.

bones were radiographed again six months after the first examination and no significant change was detected. *Left leg*—The lesion involved the whole of the tibia and fibula (Fig. 2) and all the bones of the foot (Figs. 4 and 5). There was a small zone of abnormality in the left lower

femoral epiphysis (Fig. 3). The bones were irregularly expanded, their cortices were thin, in some places not detectable. The whole thickness of the bones was occupied by fairly widely spaced coarse trabeculae. In the upper third of the fibula there was a core of coarse trabeculae in the normal line of the shaft of the bone, and radiating perpendicularly from it spicules of trabeculation ending in a faint line of calcification marking the new boundary of the bone. *The right humerus* showed a cyst-like area in the middle of its shaft (Fig. 6). The overlying bone was expanded, and its cortex thinned. Proximal and distal to the zone of rarefaction the original films showed coarse and thickened medullary trabeculation. No lesion was seen in any of the other bones of the body, and there was no suggestion of "Erlenmeyer flask" deformity in the lower portions of the femoral shafts.

Histological examination (Dr Basil Elmes)—The left tibia and right humerus were explored,

FIG. 6
Right humerus.

and in both soft friable tissue was found under a thin cortex of bone. The specimen from the tibia was soft and did not require decalcification. The bone and marrow were replaced by a vascular cellular tissue composed of fibroblasts, large pale rounded or polyhedral cells with granular or finely vacuolated cytoplasm, and a sprinkling of plasma cells, lymphocytes and eosinophils (Fig. 7). The large pale cells were conspicuous (Fig. 8) and probably contained lipoid material; they were indistinguishable from Gaucher cells. Each contained one or two small darkly staining nuclei, sometimes eccentric; in a few there were several nuclei but no giant cells of the osteoclastoma type were seen. There were a few fragments of degenerate bone but there was no evidence of bone regeneration. The specimen from the humerus showed changes essentially the same as those in the tibia, though sheets of large pale "Gaucher" cells dominated the picture and the structure was more delicate and less fibroblastic. There were also small collections of spindle-shaped cholesterol clefts not seen in the other specimen.

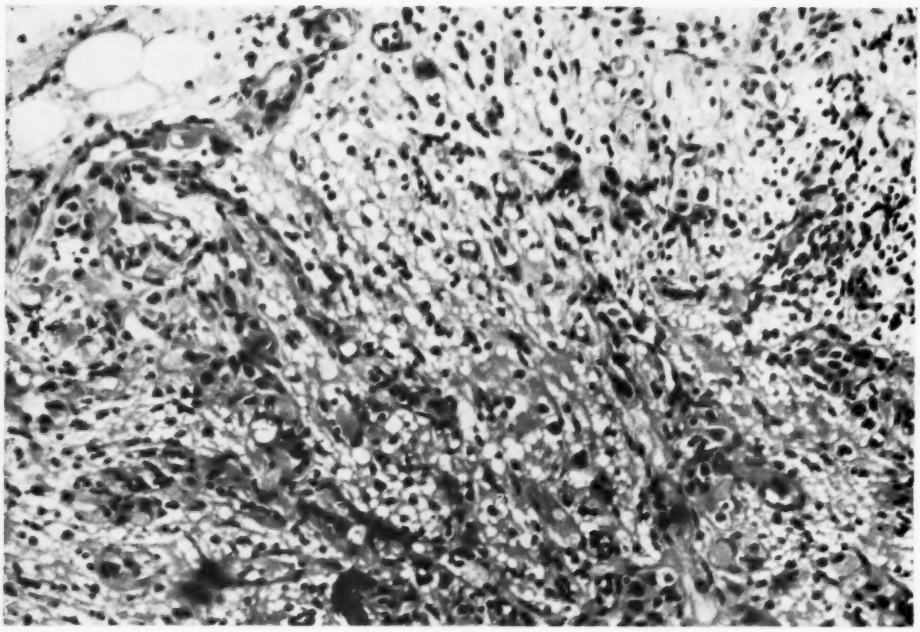

FIG. 7
Photomicrograph of section from left tibia (×60).

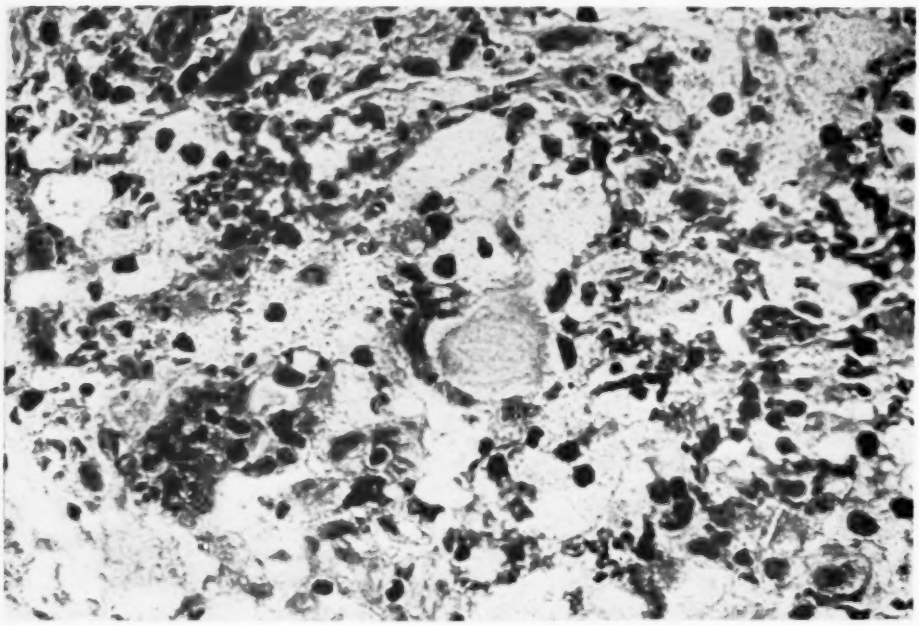

FIG. 8
Photomicrograph of section from left tibia (×320).

Subsequent history—The child's parents removed him from hospital. After repeated attempts to get him back, the medical officer of the district in which he lives persuaded them to allow him to drive the child 150 miles to Kampala for further radiographic examination. This was undertaken one and a half years after the first examination. Although there was considerable local extension of the lesions, most noticeable in the left tibia and fibula, the only evidence of involvement of bones previously unaffected was a lesion in the left lower femoral epiphysis, a suspicion of which had been detected in the previous films. The skull was still normal.

DISCUSSION

The profusely honeycombed appearance of the changes in the left leg suggested angiomatous infiltration of the bones, but the histological findings put this out of court. The involvement of every bone below the knee might be regarded as indicating a vascular error of some kind, but, apart from slightly increased warmth of the skin, there were no signs of changes in the soft tissues. The overgrowth of the tibia and fibula was probably explained by the abnormal vascularity of the bones.

The lesion in the humerus was compatible with a diagnosis of several different affections, including fibrous dysplasia and one of the lipoidoses: the histology seems to point towards the latter. Though the finding of foam cells in a section does not absolutely exclude fibrous dysplasia, the number present in this case, and their presence in both humerus and tibia, seemed to favour a diagnosis of one of the lipoidoses. According to Snapper (1949) mistakes are more likely to be made in the opposite direction, since secondary fibrotic changes in an old lesion in one of the lipoidoses, with disappearance of all lipoid-containing cells, may readily lead to a wrong diagnosis. He advocated the selection of what appears to be a young lesion for biopsy in a doubtful case.

Somewhat similar honeycombing of several bones in a foot has been described, but this was in a case of angio-endothelioma (Fairbank 1951). Hauser and Constant (1948) reported a case with extensive honeycombing of the pelvis and upper femora, very suggestive of the changes seen in this case, but this also proved to be due to angio-endothelioma. A case of interest is that published by Parsons and Ebbs (1940) which, curiously enough, was regarded as Gaucher's disease until the child died from an attack of broncho-pneumonia, when complete post-mortem examination revealed that the widespread cystic changes in the skeleton were due to cavernous angiomata: similar changes were found in the spleen and other organs and also in the soft tissues.

We know of no other case, not even of the most widespread polyostotic fibrous dysplasia, which showed such complete and almost uniform changes in all the bones of the distal half of a limb as are seen here: the profuseness of the changes appears to be unique. We suggest that this case must be regarded as belonging to one of the lipoid reticuloses, possibly of the Gaucher type, but the absence of enlargement of the spleen is a strong point against this last suggestion.

Our thanks are due to Mr T. N. Salthouse for the photograph.

REFERENCES

FAIRBANK, Sir H. A. T. (1951): An Atlas of General Affections of the Skeleton, p. 378. Edinburgh and London: E. & S. Livingstone Ltd.

HAUSER, E. D. W., and CONSTANT, G. A. (1948): Skeletal Hemangio-Endothelioma. Journal of Bone and Joint Surgery, **30-A,** 517.

PARSONS, L. G., and EBBS, J. H. (1940): Generalized Angiomatosis Presenting the Clinical Characteristics of Storage Reticulosis. Archives of Disease in Childhood, **15,** 129.

SNAPPER, I. (1949): Medical Clinics on Bone Diseases. Second edition, pp. 214–5. New York: Interscience Publishers, Inc.

OSTEOCHONDRITIS OF THE SUPERIOR TIBIAL EPIPHYSIS

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From the Nuffield Orthopaedic Centre, Oxford

So far as we are aware, osteochondritis of the superior tibial epiphysis has not previously been described. It is, therefore, of interest to report the radiographic changes which were found in the superior tibial epiphysis of a boy aged twelve years, and which appear similar to those seen in osteochondritis elsewhere.

CASE REPORT

When the patient was first seen he complained of pain in the right knee of three months duration. There was no history of injury or recent illness; physical examination and radiographs were negative. He was kept under observation as an out-patient for three months. He was then admitted to hospital on account of local swelling, slight increase in heat and tenderness over the lateral tibial condyle. Radiographs showed evidence of increased density of the tibial epiphysis (Fig. 1).

Fig. 1

Fig. 2

Figure 1—Radiograph at time of admission, five months after the onset of symptoms.
Figure 2—Seven months after onset.

During the next three months, investigation showed a consistently normal temperature and blood count. The Wassermann and Kahn reactions, agglutinations to salmonella and b. abortus and the Mantoux reaction were all negative. The blood sedimentation rate remained below 10 millimetres, apart from one rise to 25 millimetres. Radiographs two months after admission showed further increase in the epiphysial density (Fig. 2). This reached its

greatest nine months after the onset (Fig. 3). Needle biopsy of the epiphysis showed a low-grade inflammatory reaction with no evidence of bone necrosis or absorption. An inguinal lymph gland removed at the same time was histologically normal.

Progress—Within a year of the first symptoms, the knee appeared quiescent. The radiograph showed advanced revascularisation (Fig. 4) and he was discharged in a non-weight-bearing

FIG. 3

FIG. 4

FIG. 5

Figure 3—Nine months after onset. Figure 4—Eleven months after onset. Figure 5—Two and a half years after onset.

plaster. Subsequent progress was satisfactory; unprotected weight bearing was permitted a year and a half after onset of symptoms.

The patient was last seen two and a half years after the onset. He was indulging in normal activities without symptoms. Physical examination was negative, apart from slight wasting of the quadriceps. Radiographs showed a general improvement in the appearance of the bone (Fig. 5).

DISCUSSION

The diagnosis in this case lay between a pure ischaemic lesion and a low-grade infection in the epiphysis. Repeated blood counts and tests of sedimentation rate were normal except for one high reading of 25 millimetres in one hour. The temperature was consistently normal. No antibiotic treatment was given. The low-grade inflammatory reaction found on needle biopsy could be consistent with either lesion.

The clinical course and the radiographic findings of sclerosis followed by resorption and satisfactory reorganisation one year later suggest that this condition might be classed as an osteochondritis of the superior tibial epiphysis.

REGENERATION OF THE LOWER FEMORAL EPIPHYSIS

Report of a Case

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This case is considered to be of interest because, after a lapse of at least four years since its destruction, the medial condylar part of the lower femoral epiphysis appears to be regenerating. The patient had suffered from suppurative arthritis of the knee joint with epiphysitis of the femur at the age of three weeks, resulting in complete destruction of the medial condylar part of the epiphysis (Fig. 1).

He was first referred to me, when he was ten and a half months old, because of increasing genu varum. The previous history was that at the age of three weeks pus containing staphylococcus aureus was aspirated from the distended, painful knee and replaced with a corresponding amount of sterile normal saline containing 40,000 units of penicillin. Plaster and light traction were applied. Administration of penicillin was continued both by daily replacement for twelve days and parenterally for the same twelve days and another four. Sulphadiazine was given from the ninth to the eighteenth day.

The genu valgum was treated at first with a Thomas's bed knee splint and, after four months, with a Thomas's caliper. A year later it was doubtful whether there had been any improvement. The patella was lying over the lateral condyle and slipped medially on flexion

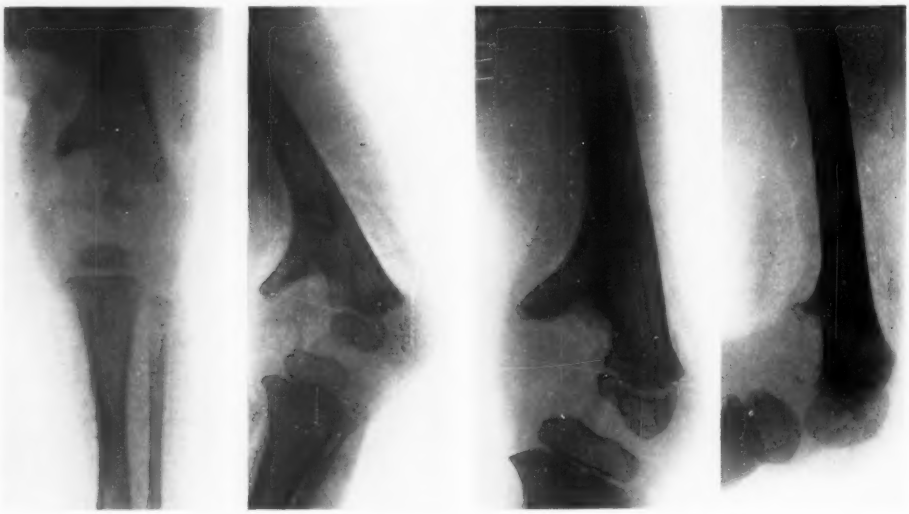

Fig. 1 Fig. 2 Fig. 3

Figure 1—Early radiograph three months after onset of suppurative arthritis and epiphysitis. Figure 2—One year later. Figure 3—Four years later.

of the joint. After a further year the patella no longer slipped sideways. The leg was one and three-quarters inches short. Three years after his first attendance the clinical condition was the same. There was no increase in the bowing, but no apparent growth in the medial condyle. The radiographs (Fig. 3) showed what might be regarded, in the light of subsequent progress,

as commencing regeneration of the epiphysis on the medial condyle; and the angle of the epiphysial line on the lateral condyle had improved from a varus angle of about 45 degrees to one of 20 degrees.

The patient was last examined seven years after his first attendance. The knee was

FIG. 4

Condition seven years after onset, showing partial regeneration of the medial femoral condyle.

then stable and straight; the range of flexion was about 70 degrees. During movement a click was felt over the prominent lateral condyle, and the patella was felt to hide in the gap where the medial condyle of the femur should be. The limb was about two inches short. The clinical impression was that the medial condyle was redeveloping. Radiographs (Fig. 4) confirmed this.

DYSPLASIA EPIPHYSIALIS PUNCTATA

Report of a Case and Review of Literature

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Punctate epiphysial dysplasia is a rare congenital disorder of infancy affecting mainly cartilage, the soft tissues of the locomotor system such as muscle and joint capsule, and the eyes. Most text-books make no mention of the disorder and few reports have appeared in the literature. Fairbank (1927) was able to find only sixteen case reports, Savignac (1952) only twenty-two, and Putschar (1951) thirty-five. Few had been examined histologically. The rarity of the condition and the histological study have prompted publication of this case.

Conradi (1914) published the first clinical, histological and radiological description of this disease which he called " chondrodystrophia foetalis hypoplastica," which is considered by other writers to be an example of punctate epiphysial dysplasia. Fairbank's first two cases (1927) were described under the title of "epiphysial dysplasia puncticularis"; the name punctate epiphysial dysplasia was suggested by Weber (1936). The names are perhaps misleading, as indicating only skeletal affection, whereas the soft tissues and the eyes are also involved. Many other names have been used in American and Continental literature, the commonest being " chondrodystrophia calcificans congenita." Other synonyms are " chondroangiopathia seu punctata," " stippled epiphyses," and " hypoplastic foetal chondrodystrophy."

The cases described were in infants only, and most of these died in the first few years of life. Fairbank (1951) was unable to find any later report of a case showing generalised changes. Mosekilde (1952) mentioned cases in which the development had been followed over a number of years, but no report is available of a patient living to adult life. Nevertheless Haynes and Wagner (1951) stated that the stippling does heal. In the early phase of healing it is said to resemble aseptic necrosis and the completely healed phase shows linear striae from epiphysial plate into metaphysis.

Etiology and pathology are obscure. Mosekilde (1952) suggested a disturbance of calcium metabolism in mother and child. According to Cocchi (1950) there is a disturbance of blood supply to the epiphyses, especially in the arrangement of the vessels, and the cartilage columns lose their parallel pattern. This observation caused him to suggest the name " chondroangiopathia " as descriptive of the abnormal blood vessels of the cartilage columns seen on histological examination. Harris (quoted by Fairbank 1951) found, as in achondroplasia, patchy mucoid degeneration and cystic spaces in the cartilaginous epiphyses. This observation appears to be confirmed by the histological study of the present case. Haynes and Wagner (1951) reported a case in a sibling of a previously stillborn achondroplasic. The disease is not hereditary but is possibly familial (Maitland 1939, Haynes and Wagner 1951).

The clinical picture is variable but certain signs are common to most of the patients described. These are: 1) flexion deformities of joints, most commonly the knees and elbows, ascribed to fibrosis of muscle and joint capsule rather than to changes in the epiphyses; changes in the soft-tissue structures give the limbs a swollen appearance; 2) bilateral congenital cataract; and 3) dwarfism of the short-limb type, as in achondroplasia. This was well illustrated in the present patient, diagnosed *in utero* as a foetal achondroplasiac. The parts most affected are the femora and humeri. The shortening is not necessarily symmetrically equal and a single limb may be affected.

The condition must be distinguished from other diseases presenting mottled, irregular epiphyses—namely, cretinism and dysplasia epiphysialis multiplex.

CASE REPORT

A Bantu woman in her fifth pregnancy was referred from the ante-natal clinic of the King Edward VIII Hospital, Durban, for radiography on account of hydramnios which rendered palpation of the abdomen difficult. Her previous obstetric history was normal. The fourth child, apparently quite well at birth, had died after a week, from unknown cause. *Ante-natal radiographs* disclosed a foetal abnormality resembling achondroplasia (Fig. 1). The stippling of the epiphyses could be seen at this stage, through the hydramnios. Three and a half weeks later, at full term, the patient was delivered of a stillborn infant (Fig. 2). The most striking feature of the foetus was the deformity of the limbs, which were short,

FIG. 1

FIG. 2

Figure 1—Ante-natal radiograph showing short limbs and faint stippling. Achondroplasia was suspected. Figure 2—The stillborn foetus showing the short limbs, contractures and the opened mouth presumably due to subcutaneous thickening.

thickened and stubby, especially the left thigh and arm and the left foot. There were well marked flexion deformities of the right knee and left elbow and ulnar deviation at the left wrist. The skull was apparently normal but the mouth was gaping.

Post-natal radiographs were very striking. The sacrum, lumbar and lower thoracic vertebrae consisted almost entirely of opaque dots about a millimetre in diameter, mostly discrete but in places coalescing (Fig. 3). The pelvic bones showed the same stippling, especially in the pubic rami and acetabulum. The alae of the iliac bones were well ossified but the epiphysis of the iliac crests, which normally do not appear until thirteen to fifteen years, were present and stippled (Fig. 3). This premature appearance of epiphyses is described as a feature of the disease. Fairbank mentioned that no case examined by him showed stippling in the iliac crests. The femora showed stippling at both proximal and distal epiphyses (Fig. 4). The left femoral diaphysis was shortened, thickened and bowed, and showed a pseudo-fracture.

The patella and all epiphyses of the tibiae were stippled. The tarsus consisted entirely of calcified spots with little resemblance to the normal anatomy (Fig. 5). The scapulae showed stippling only at the inferior angles but the left glenoid was deformed. All the epiphyses of the arm and forearm were stippled. The left humerus, radius and ulna, like the left femur, had short, thick diaphyses, and the left radius was much bowed (Fig. 6). The sternum consisted almost entirely of this punctate calcification, and the same appearance was seen in some of the costal cartilages. The hyoid bone and cricoid cartilage were entirely stippled. Faint stippling of base of skull appeared to be present.

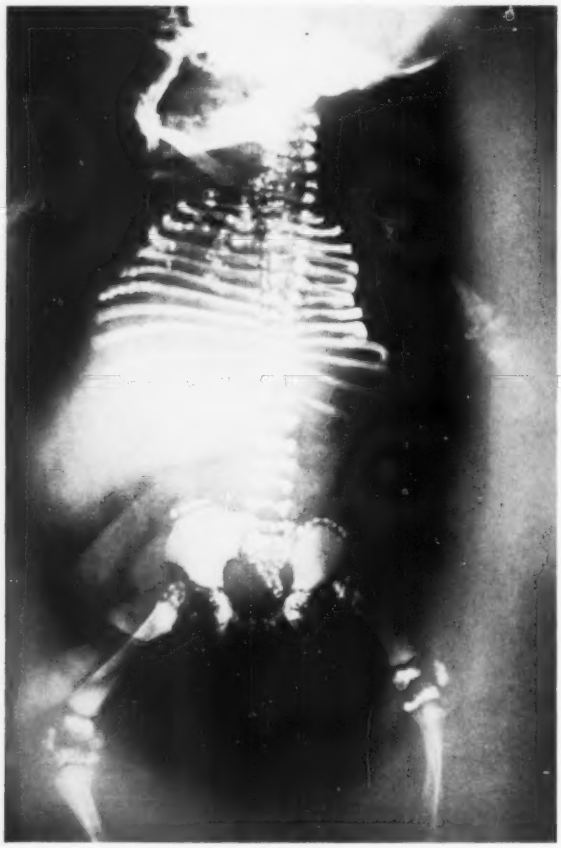

FIG. 3

Radiograph of foetus showing stippling of all epiphyses, the vertebrae and sternum. The base of the skull is sclerotic.

Histological examination (Dr J. Wainwright)—Specimens of bone and cartilage from a femur and costal cartilages were examined. These showed irregular areas of calcification in the cartilage, often surrounded by smaller discrete calcifying foci. In the costal cartilages there appeared to be patchy mucoid degeneration preceding the calcification. Here the cartilage cells had disappeared, and the matrix showed a foamy appearance. Calcified plaques appeared separated by granules of calcified material in the metachromatic-staining stroma. These probably later coalesced near the surface. The calcifying areas were in some places invaded by granulation tissue with osteoclastic cells reabsorbing the calcified material. In the femoral

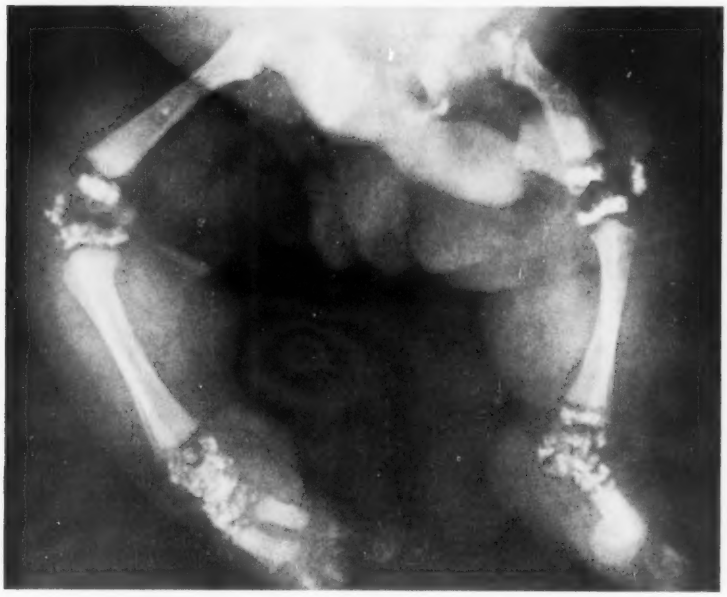

FIG. 4
Lower limbs showing stippling of epiphyses. Note also the marked shortening of the left femur and the pseudo-fracture at its midshaft.

FIG. 5

FIG. 6

Figure 5—Right foot showing extensive stippling of the distal tibial and fibula epiphyses and of the tarsal bones. The left foot was similar. Figure 6—Left upper limb showing short diaphyses of humerus, radius and ulna. Note also the bowing of the radius and extensive epiphysial stippling.

epiphysis, however, there were irregular calcified areas in which the cartilage cells were still seen, although their nuclei were undergoing fragmentation (karyorhexis). At the periphery groups of calcified cartilage cells were seen with normal cartilage cells remaining in between. The upper femoral epiphysis appeared normal, but the lower was grossly irregular with failure of orientation of the cartilage cells into columns. Evidence of disordered ossification was also shown by clumps of cartilage in the medullary cavity of the shaft of the femur.

SUMMARY

Radiological and histological examinations are described in a full term stillborn infant with punctate epiphysial dysplasia diagnosed *in utero* as achondroplasia.

Thanks are due to Dr J. Parker, Medical Superintendent, and Dr A. L. Gilbey of the Department of Obstetrics, King Edward VIII Hospital, Durban, for permission to publish this case; to Dr J. Wainwright for the histological studies; and to Miss M. McClaggen of the Department of Medical Photography for the photographic reproductions.

REFERENCES

BATEMAN, D. (1936): Two Cases, and Specimens from a Third Case, of Punctate Epiphyseal Dysplasia. Proceedings of the Royal Society of Medicine (Section for the Study of Disease in Children), **29, 745**.

COCCHI, U. (1951): Chondro-angiopathia Calcarea seu Punctata. *In* Schinz, H. R., *et al.*: Roentgen Diagnostics, Vol. 1 (Skeleton (Pt. 1), p. 687. Based on the fifth German edition. London: William Heinemann, Medical Books, Limited.

CONRADI, E. (1914): Vorzeitiges Auftreten von Knochen—und eigenartigen Verkalkungskernen bei Chondrodystrophia fötalis hypoplastica. Histologische und Röntgenuntersuchungen. Jahrbuch für Kinderheilkunde, **80,** 86.

FAIRBANK, H. A. T. (1927): Some General Diseases of the Skeleton. British Journal of Surgery, **15,** 120.

FAIRBANK, Sir H. A. T. (1951): An Atlas of General Affections of the Skeleton, p. 102. Edinburgh and London: E. & S. Livingstone Ltd.

HAYNES, E. R., and WAGNER, W. F. (1951): Chondroangiopathia Calcarea seu Punctata. Radiology, **57,** 547.

MAITLAND, D. G. (1939): Punctate Epiphyseal Dysplasia Occurring in Two Members of the Same Family. British Journal of Radiology, **N.S. 12,** 91.

MOSEKILDE, E. (1952): "Stippled Epiphyses" in the Newborn and in Infants. Acta Radiologica, **37,** 291.

PUTSCHAR, W. G. J. (1951): Chondrodystrophia Calcificans Congenita (Dysplasia Epiphysialis Punctata). Bulletin of the Hospital for Joint Diseases, **12,** 514.

SAVIGNAC, E. M. (1952): Chondrodystrophia Calcificans Congenita. Radiology, **58, 415.**

WEBER, F. Parkes (1936): *In* Discussion of Bateman, D. (1936), p. **747.**

ALBERS-SCHÖNBERG DISEASE (MARBLE BONES)

Report of a case with a study of the chemical and physical characteristics of the bone

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The condition called osteopetrosis by Karshner (1926) was first described accurately by Albers-Schönberg (1904), and in a subsequent article (1907), on the basis of the radiographic appearance, he likened the bones to marble. That the condition is commonly referred to eponymously emphasises the lack of precise information about the mechanical abnormalities resulting from the striking physical peculiarities of these bones. Indeed, not only are there very few records of investigations made at necropsy into these abnormalities, but there is also considerable divergence of the opinions expressed by surgeons on the characteristics of the bones at operation. Two of these opinions may be given to exemplify this divergence. On the one hand Henderson (1928) stated that the bones are "so hard that they break the edges of chisels and drills." On the other hand Pirie (1930) found that the amount of penetration of a normal bone that could be achieved by twenty-three turns of a certain drill required only seven turns in a case of this disease. The most recent review of Albers-Schönberg's disease was that of Fairbank (1951), which included seven personal case reports. He stated that all cases show abnormal bone density to x-rays and that, although a tendency to an excessive number of fractures may be present, " on the whole the fragility of the bones has been much exaggerated."

This is a rare disease and, so far as can be discovered, the case reported here is the first that has come to post-mortem at Guy's Hospital—an incidence of the order of one in 10,000 hospital necropsies. The case afforded the opportunity to investigate the exact nature of the physical and chemical abnormalities of the bones and the resulting observations are the subject of this paper. Fairbank's (1951) comprehensive account has been taken as the basis for the diagnosis and it may be said at once that this patient conforms well with his description.

CASE REPORT

A woman aged forty-one was admitted to the neurosurgical unit of Guy's Hospital, under Mr Murray Falconer, for the treatment of a subarachnoid haemorrhage. She had had three verified attacks of the same condition in the three weeks before admission. During the fourth attack she developed a right hemiparesis and died in coma.

During the previous two years she had several times a day felt numbness in the left side of the face and head which she described as " coldness and pins and needles." She had always required especially large hats; there was no history of fractures. Her father died of a " tumour of the head " but there was no evidence of bone disease in the other two members of the family who have been traced.

On examination at the time of admission, abnormal neurological signs were found which, since they changed their character while under observation, were almost certainly due to haemorrhage. Gross myopia (8–9 dioptres) was present but there was no optic atrophy or deafness. *Radiographs* showed increased bone density in the proximal ends of the femora and tibiae and particularly marked changes in the skull. So dense was the skull that few cranial details and no vascular pattern at all could be seen after right carotid arteriography. *Investigations*—A blood count made three weeks before admission showed the following:

haemoglobin 72 per cent (11 grammes per cent); red blood corpuscles 4,150,000 per cubic millimetre; white cells 15,400 per cubic millimetre (neutrophils 80 per cent, myelocytes 3 per cent, lymphocytes 15 per cent, monocytes 1 per cent, basophils 1 per cent). Thus there was mild anaemia, a slight neutrophil leucocytosis and a few myelocytes; but no primitive white cells were found in any subsequent investigation. Apart from the myelocytes the count was consistent with the history of repeated subarachnoid haemorrhages.

Necropsy was performed twenty hours after death. The body was that of a well nourished woman of small stature (height: 4 feet 11 inches [150 centimetres]) with an exceptionally large head. Bilateral basal broncho-pneumonia was present and there was a benign left ovarian teratoma. The parathyroid glands were normal (combined weight 142 milligrams). No evidence of extramedullary haemopoiesis was found and the other organs were normal.

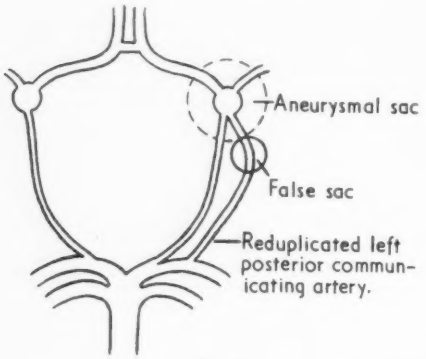

FIG. 1
Diagram of the congenital abnormality of the circle of Willis.

The brain itself was normal but there was a large haemorrhage into the left lateral and the third ventricles arising from a ruptured berry aneurysm at the divergence of the left anterior and middle cerebral arteries. The haemorrhage had extended into the pituitary fossa. A similar but smaller aneurysm was present on the right. A further congenital anomaly of the intracranial vessels was reduplication of the left posterior communicating artery (Fig. 1).

The skeletal abnormalities were widespread and variable. The calvarium was enormously thickened (mean thickness 1·7 centimetres) and showed no differentiation into inner and outer tables, being composed of compact bone throughout. In consequence it was very heavy, weighing 1,208 grammes (mean weight of five normal adult female calvaria cut similarly was 302 grammes). The cranial cavity was not diminished, the increase in size of the head being due solely to external thickening of the skull. The dura separated normally. All the normal promontories inside the skull were greatly hypertrophied but there was no foraminal narrowing; for example the right optic foramen measured five by six millimetres. There were no air spaces in the mastoid parts of the temporal bones but there were some small ones, about three millimetres in diameter, in the sphenoid bone. One of each of the long bones was examined and all showed similar changes. The cortices were thickened, and thickening of the trabeculae gave a coarse medullary pattern. The cortical changes were most marked at the middle of the humerus, tibia and femur (mean thicknesses seven, seven and ten millimetres respectively) and the abnormal medullary pattern in the lowest third of the humerus (Figs. 2 and 3). There was very little marrow in the long bones, but the vertebral bodies, apart from the trabecular pattern, looked normal.

Histological examination—The unruptured smaller aneurysm had a thin wall composed of endothelium-lined fibrous tissue only. At the margin of the sac the media and intima of the artery disappeared, the elastica about a millimetre before the rest, so that the adventitia alone formed the wall of the dilation. The haemorrhage into the pituitary fossa had invaded the gland so that only about half of the anterior lobe tissue remained. A small parapituitary epithelial rest or " adamintoma " was present. The parathyroid glands were of predominantly chief cell type and the pancreatic islets were abnormally numerous and large. No evidence of extramedullary haemopoiesis was seen.

The bones showed coarse trabeculation (Fig. 4) with little cellular evidence of osteoblastic or osteoclastic activity, although this was probably within normal limits. As far as could be

FIG. 2

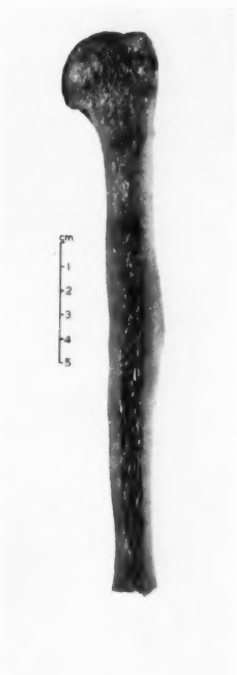

FIG. 3

Figure 2—Radiograph of hemisected humerus. Figure 3—Humerus cut longitudinally.

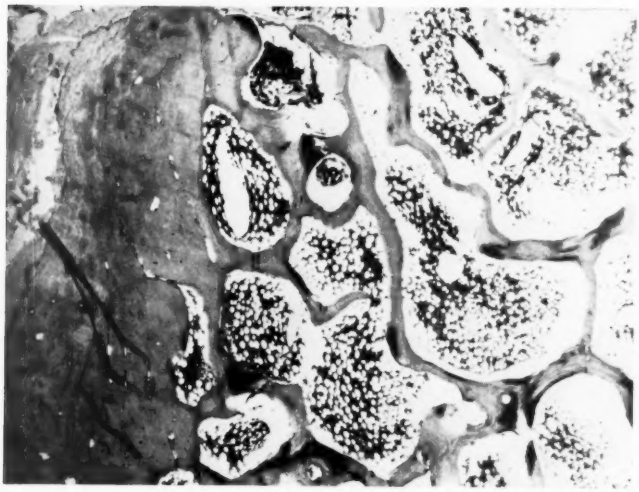

FIG. 4

Subcortical marrow of upper end of tibia (H. and E. × 12).

judged from sections that required prolonged decalcification there was no abnormality of haemopoiesis. Section of the lower part of the tibia at the point where the cortex narrowed to normal width did not show any advancing edge of the pathological process.

The ovarian tumour was a benign teratoma showing elements derived from all three germinal layers (hairs, columnar cells similar to those found in intestinal epithelium, and bone).

Chemical investigations—These were made on dried turnings of cortical bone. The findings are shown in Table I. As they all fall within accepted normal ranges the methods are not described but references to them are given in the footnotes to the Table.

TABLE I

CHEMICAL COMPOSITION OF THE BONES

	Weight per cent of dry bone				
	Normal femur	Normal tibia	Patient's femur	Patient's tibia	Patient's skull
Calcium (as Ca)	25·8	25·8	25·3	26·3	25·9
Phosphorus (as PO_4)	33·7	34·0	34·9	34·2	35·0
Carbonate (as CO_3)	4·1	4·9	4·3	4·9	4·9
Nitrogen	4·3	4·3	3·7	4·2	4·3
Hydroxyproline*	—	3·15	—	3·13	—
Collagen (Mean of results calculated from N and hydroxyproline contents)	23·3	23·2	23·4	23·6	24·9
	Weight per cent of collagen				
Tyrosine†	—	1·28	—	1·23	—

* Neuman and Logan 1950. † Rogers, Weidmann and Parkinson 1952.

Physical investigations—Measurements were made, on isolated cortical bone, of the specific gravity, Young's modulus of elasticity, and breaking strength; the resistance of the bone surface to a standard penetrating force was also determined.

For the first three measurements, rods of bone were turned on a lathe from strips sawn from the cortex of the upper end of the femur on its medial aspect just below the neck, from the crest of the tibia just below the epiphysial line, and from the right frontal bone just anterior to the fronto-parietal suture two centimetres above and parallel to the supra-orbital ridge. Two skull specimens were examined: one taken from bone macerated in 10 per cent caustic soda for two months, and one from untreated bone. The rods were about four centimetres long and were 0·358 centimetres in diameter giving a circular cross-section of 0·1 square centimetres. Six controls from patients of similar age were examined, in none of whom was the cause of death likely to have caused any bony abnormality. The first was prepared from a femur but it was found simpler to obtain subsequent specimens from the tibial crest. Normal skulls were found to contain insufficient compact bone to permit turning of similar rods and the same was true of a case of hyperostosis frontalis interna. All bones examined had been preserved in 4 per cent formaldehyde.

The specific gravity was calculated from data obtained by measuring the lengths of the pieces, calculating their volumes, and subsequently weighing them.

The other measurements were made by applying weights to the central point of a bone peg suspended in a brass cradle of 2·86 centimetres internal diameter. A counterpoised arm

in contact with a recording device allowed measurements of deflection to be made (Figs. 5 and 6). Young's modulus, or the modulus of longitudinal elasticity, was obtained by plotting these deflections against the weights causing them; it was found that they invariably formed a straight line right up to the point at which fracture occurred (Fig. 7). From the graphs so obtained the mean deflection for a unit weight was obtained and the Modulus, E, was calculated from the formula: $E=\frac{Wl^3}{12r^4}\times\frac{I}{d}$ dynes per square centimetre, when l is the length of the peg within the cradle, r its radius and d the amount of depression caused by the addition of a force W dynes.

A simpler apparatus was used for the measurement of breaking stresses. It was composed

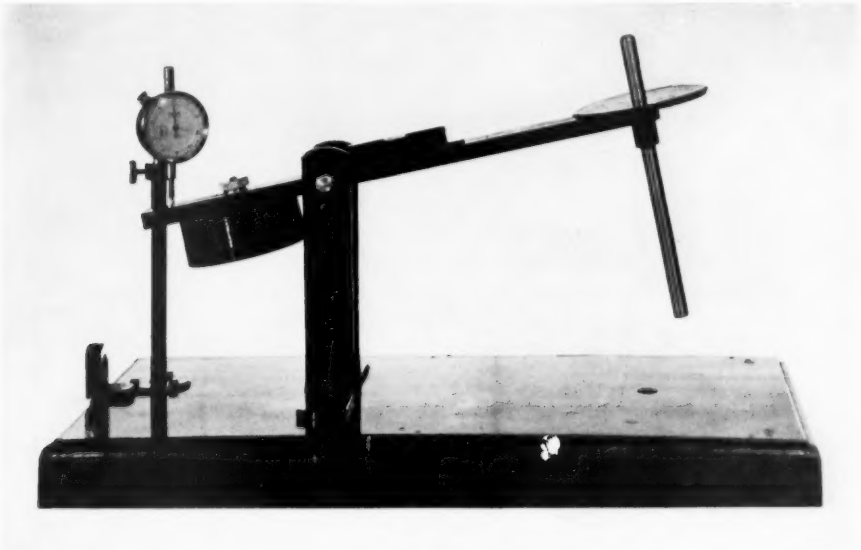

FIG. 5

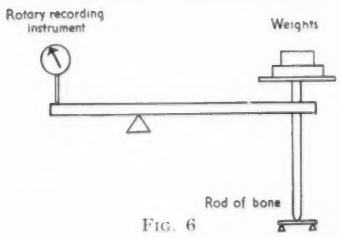

FIG. 6

A photograph (Fig. 5) and diagram (Fig 6) of the moving parts of the apparatus used for the measurement of strain.

of a circular platform ten centimetres across soldered on to a tapered brass rod one centimetre in diameter that ran through a loosely fitting tube held vertically in a burette clamp (Fig. 8). The tip of the rod was allowed to rest on a bone peg suspended in the same cradle as before and half-kilogram weights were added to the platform one at a time until the rod broke. Histological sections were cut transversely close to the fractured surface to confirm that the long axis of the peg was along the Haversian systems, and counts were made of their number in each peg (Table III).

The penetration caused by applying a weight of 10 kilograms to a hard steel needle—the point, which formed an angle of 60 degrees, resting on the surface of a bone—was measured in the large apparatus; care was taken to avoid errors from elastic compression.

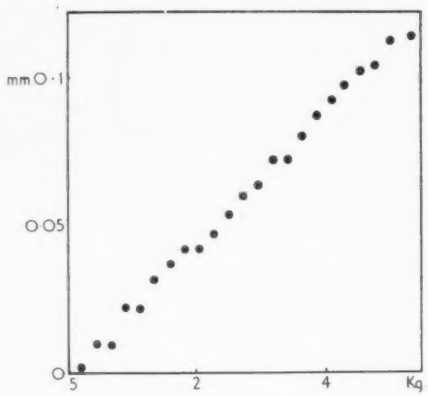

FIG. 7

Showing the deflections caused by the addition of successive weights each of 230 grammes.

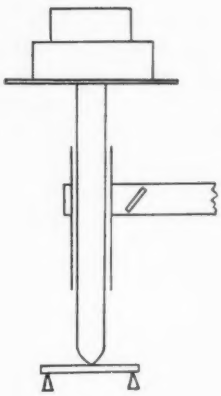

FIG. 8

Diagram of the apparatus used for the measurement of breaking strength.

TABLE II

PHYSICAL CHARACTERISTICS OF THE BONES

Source of compact bone	Young's modulus ×10	Breaking point in kilograms	Penetration in centimetres caused by a weight of 10 kilograms	Specific gravity
Normal tibia (5 specimens)	9·8 (s.d. ±1·2)	13·8 (s.d. ±2·2)	0·05 (s.d. ±0·003)	1·46 (s.d. ±0·18)
Normal femur (1 specimen)	11·2	18·0		
Normal skull (2 specimens)			0·04	
Patient's tibia	13·7	21·0	0·06	1·94
Patient's femur	13·4	18·0	0·07	2·16
Patient's skull: not macerated . . .	9·6	10·0	0·03	1·72
macerated	6·0	7·0		1·86

TABLE III

NUMBER AND DISPOSITION OF THE HAVERSIAN SYSTEMS SEEN IN HISTOLOGICAL SECTIONS OF THE BONE PEGS ON WHICH THE PHYSICAL MEASUREMENTS WERE MADE

Source of compact bone	Number of Haversian systems per square centimetre	Number cut transversely	Number cut obliquely
Normal tibia	920 (s.d. ±134)	880	40
Patient's tibia	1090	1080	10
Patient's skull	340	230	110

RESULTS

The results are summarised in Table II. The readings for the one specimen of normal femur investigated come within the range for the five specimens of normal tibiae, so that this range may be taken to represent the behaviour of normal long bone cortex. The values for the abnormal femur and tibia are likewise similar and will be considered together. Those for the skull, before and after maceration, although interesting, are quite different from any of the other results. This is what might be expected from the nature of the stresses to which this part of the skeleton is liable and is reflected by the appearance of the cross-sections of the rods (Table III). These show that whereas the Haversian systems of the normal and abnormal long bones are arranged similarly and are mostly parallel to each other, they are much less regular in the pathological compact bone of the abnormal skull.

If the values for normal and abnormal long bone cortex given in Table II are compared it is seen that the abnormal bone is more rigid (that is, it has a greater modulus of elasticity) than the normal and that this difference exceeds conventional limits of significance. In keeping with this, but in contradiction to much current surgical opinion, the force required to break abnormal tibial bone was greater than that needed for the normal, but the breaking stresses for the abnormal and normal femora were the same. The readings are few and the observed differences not great enough to establish the existence of any definite difference in behaviour, but they do at least make it certain that in this patient, who had no history of fractures, the bone fragility was not increased. Maceration of the skull greatly increased the ease with which the frontal bone pegs bent and fractured (if the samples were comparable).

The standard penetration test applied also revealed significant abnormalities. There was no difference between the values for normal skull and normal tibia but marked differences were present in the comparable values for the abnormal bones. The calvarium resisted penetration but the long bones, both of which behaved similarly, were more easily entered by the needle.

The specific gravity of all the abnormal bones was considerably greater than the normal mean, and that of the long bones was significantly outside the normal range.

DISCUSSION

There can be no reasonable doubt that this patient had Albers-Schönberg's disease. Although there was no history of fractures and no family history, the disease had been present for a very long time and probably from early childhood. The age (forty-one years) of death does not diminish the probability that this is the correct diagnosis, for in a series of twenty-nine cases (Nussey 1938, Fairbank 1951) eight patients were over forty and only fifteen were children. Necropsy revealed no other cause for bone disease and showed numerous features entirely consistent with the diagnosis made. In addition several congenital abnormalities (multiple intracranial berry aneurysms, a parapituitary epithelial rest and a benign ovarian teratoma) are perhaps further evidence that the condition of this patient's bones was the result of a developmental error. It may then be concluded that the case has been correctly diagnosed.

The physical characteristics of the abnormal bone are the most interesting of the findings and it is thought that they may have a bearing upon the differences of opinion that have long existed about this disease. Their main characteristic is the marked contrast between the values for skull and long bones which, in general, fall on opposite sides of the mean values for the normal tibia. The only exception is the specific gravity, all the marble bones being denser than the mean for the normal tibia. Despite this the difference between skull and long bones is still apparent, for whereas the former falls within the normal range that of the latter is outside its upper limit. The skull is thus harder than normal and bends and breaks more easily, whereas the long bones are softer and more resilient and resistant to fracture. Although

not all of these deviations are significant they do suggest that the changes in the bones in this condition are of a patchy distribution, a finding which accords with the radiographic appearances in this and other cases. Although the data presented here relate only to the strength of the bones in the various anatomical sites in this one quiescent case at the time of death, it is at least possible that these changes also varied in distribution during the course of the disease. Thus it may well be that younger patients have more of the fragile type of bone and less of the stronger kind, the proportion of the latter increasing as age advances. It seems more probable in this case, however, that the behaviour of the bone in these mechanical tests was related to the functions that they usually performed and, through these, to the arrangement of the Haversian systems in the compact bone. Thus the bone most resistant to fracture was from the thickened tibial cortex and the least resistant was from the abnormal cortical bone of the skull. The former was constantly subjected to longitudinal stresses and the lacunae were mostly parallel to each other, whereas in the latter these stresses were minimal and the arrangement of the lacunae was more haphazard.

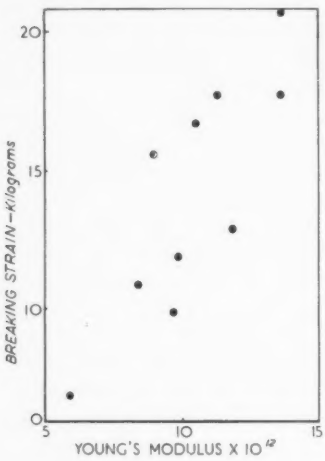

FIG. 9

Diagram showing the correlation of the values of the elastic moduli with those of breaking strain.

The greater specific gravity of the abnormal bones is probably related to the size of the Haversian canals, which appear in the sections to be somewhat smaller than normal. The specific gravity did not correlate well with either penetration or breaking point but it did with the estimates of Young's modulus. The latter also correlated quite well with the measurements of penetration and the breaking point determinations (Fig. 9), a fact which suggests that the simpler method is probably quite as useful for the investigation of future cases as the more elaborate determinations of Young's modulus.

The marked change in behaviour of the compact bone of the skull after maceration suggests that the strength of the bone depends partly upon its collagen content. The nitrogen analysis of these bones showed that this was normal and the hydroxyproline and tyrosine analyses of both normal and abnormal tibiae supported this. Collagens are unusual among proteins in containing 13 to 14 per cent of hydroxyproline (Neuman and Logan 1950) and less than 1 per cent of tyrosine (Neuman 1949). Determinations of the former amino-acid are considered specific for collagen and the presence of more than 1 per cent of tyrosine in bone collagen indicates the presence of a small amount of non-collagenous protein (Rogers, Weidmann and Parkinson 1952). That all analyses of these bones were normal, even in this last important detail, suggests that the disease is due to a micro-structural defect, not to anomalous bone metabolism, and the histological findings support this conclusion. It cannot therefore be claimed that any new light has been thrown on the pathogenesis of the disease.

In view of these results osteopetrosis is no more acceptable as a name for this condition than is marble-bone disease, the latter having historical priority as well as being a fairly accurate description of the naked-eye appearances. Nor would another name based upon the radiographic appearances be preferable, for there are other causes of increased opacity to x-rays, and it would be hard to find a single word that would describe the variable behaviour of these bones under stress. Until the underlying abnormality of osteogenesis has been discovered it may therefore be as well to continue to describe the disease either by the eponymous title of Albers-Schönberg's disease, or by the descriptive one of marble bone disease, according to the preference of the user.

SUMMARY

1. A case is described of the marble bone disease of Albers-Schönberg in a woman of forty-one who died from subarachnoid haemorrhage. Several congenital abnormalities were present.
2. No significant abnormality of the chemical composition of the bones was discovered.
3. The long bones were more resilient, stronger, softer and of higher specific gravity than normal and the abnormal compact bone of the skull was less resilient, weaker, harder and of about the same density as normal bones.
4. The simple investigation of determining the breaking strength of cortical bone yielded results similar to the more complex investigations and if applied to a larger series of cases could provide sound data on which to base speculations about this condition.

I wish to thank Mr Murray A. Falconer, Director of the Neurosurgical Unit, for permission to use the case records, and Professor G. Payling Wright who suggested the investigation. I am also most grateful to Dr W. H. H. Merivale, Reader in Clinical Pathology, Dr M. V. Stack, of the Department of Dental Medicine, and Dr I. Macdonald, of the Department of Physiology, who kindly undertook the chemical estimations and interpreted the results. The apparatus for measurement of strain was designed by Dr Macdonald.

REFERENCES

ALBERS-SCHÖNBERG, H. (1904): Röntgenbilder einer seltenen Knochenerkrankung. Demonstration 4, Aerztlicher Verein in Hamburg, February 9, 1904. Münchener Medizinische Wochenschrift, **51,** 365.

ALBERS-SCHÖNBERG, H. (1907): Eine bisher nicht beschriebene Allgemeinerkrankung des Skelettes in Röntgenbild. Fortschritte auf dem Gebiete der Röntgenstrahlen, **11,** 261.

FAIRBANK, Sir H. A. T. (1951): An Atlas of General Affections of the Skeleton. Edinburgh and London: E. & S. Livingstone Ltd.

HENDERSON, M. S. (1928): Discussion of A Case of "Marble Bone" Disease. Proceedings of the Staff Meetings of the Mayo Clinic, **3,** 10.

KARSHNER, R. G. (1926): Osteopetrosis. American Journal of Roentgenology and Radium Therapy, **16,** 405.

NEUMAN, R. E. (1949): The Amino Acid Composition of Gelatins, Collagens and Elastins from Different Sources. Archives of Biochemistry, **24,** 289.

NEUMAN, R. E., and LOGAN, M. A. (1950): The Determination of Hydroxyproline. Journal of Biological Chemistry, **184,** 299.

NUSSEY, A. M. (1938): Osteopetrosis. Archives of Disease in Childhood, **13,** 161.

PIRIE, A. H. (1930): The Development of Marble Bones. American Journal of Roentgenology and Radium Therapy, **24,** 147.

ROGERS, H. J., WEIDMANN, S. M., and PARKINSON, A. (1952): Studies on the Skeletal Tissues. 2. The Collagen Content of Bones from Rabbits, Oxen and Humans. Biochemical Journal, **50,** 537.

ABRAHAM COLLES : A TRIBUTE*

WILLIAM DOOLIN, DUBLIN, IRELAND

It was a characteristic and a graceful gesture on the part of the president to request that this session of the British Orthopaedic Association should open with a short tribute to the memory of a Dublin surgeon who in his lifetime was the unquestioned leader of his profession, and who after death has enjoyed for more than a century an eponymous immortality. That tribute, in my humble view, should most fittingly have been paid in this assembly by my old schoolfellow and colleague, Arthur Chance, who has worn the mantle of Abraham Colles for so many years as Professor of Surgery at the Royal College of Surgeons in Ireland and as surgeon to the hospital in which Colles spent a lifetime of service to the sick poor of Dublin who for more than two centuries have there been the beneficiaries of Dr Steevens's charitable bequest.

Colles, a man of exceptional modesty, would, I think, have been surprised to know how many after his death would seek to write his biography. Off-hand, one can think of Robert McDonnell, of D'Arcy Power, of Percy Kirkpatrick—the revered and beloved *doyen* of our profession in Dublin to-day—and of Arthur Rocyn Jones, whom we have long since forgiven for his innocent slip in ante-dating the birth of our younger sister College in Lincoln's Inn Fields! Where so many have set down all the facts it would be an idle task on my part to weary you with their repetition. In the short space allowed me, let me rather give you a picture of the milieu in which Colles lived and worked at the beginning of the last century.

There is a letter still extant written by William Pulteney, Earl of Bath, to a friend of John Hunter recording how, having driven down from London, and seeking a surgeon in Bath who might bleed a travelling-companion suddenly taken ill in his coach, the noble Earl was told " that there was none could do it but a man who lived three miles off, who was a good Physician, bled every Man and Calf in the neighbourhood, and was a pretty good Surgeon for he had been originally a Sow-gelder." Such stories travel fast, and that one was used by a London playwright a few years later, who gave one of his characters, a physician, the line expressing his contempt of Hunter's philosophical speculations: " Great in the noble art of gelding sows."

Such was the popular estimate of the surgeon's art in the days when, according to his first biographer, the youthful Colles was turned to his vocation of surgery by the accidental finding of an illustrated anatomy in a deserted out-house near his Kilkenny home.

You are all familiar with the assurance of Tristram Shandy that " they manage these things better in France." Some forty years before the young Colles's introduction to anatomy, the grant by Louis XV to his first surgeon, Georges Mareschal—the son of an Irish father and a French mother—of a royal charter establishing the École de Chirurgie at Paris (1731), had freed the surgeon from the educational and social shackles laid upon him by the Messieurs of the Faculty. Henceforth, the surgeon was no longer a lowly tradesman, but stood a free man " of the profession of surgery only." To the Paris school later came two Irishmen—Sylvester O'Halloran and William Dease—seeking there a professional education which, under the penal laws of the period, was denied them here at home. Profiting by their continental experience, on their return to Ireland, these two men were the prime movers in securing a Royal Charter (1784) for the foundation of the Royal College of Surgeons in Ireland. The motto, or legend, beneath the College coat of arms to-day—*Concilio manuque*—was the motto of the barber-surgeons of Paris. Dease was Dublin's first professor of surgery. Before obtaining his Letters Testimonial from the College in 1795, Colles had taken Dease's

* Paper read at the spring meeting of the British Orthopaedic Association in Dublin, April 1953.

lectures at the Surgeons' School, in which he was destined to succeed him as Professor within the decade to follow.

The stamp of the Paris teaching was evident in both men's written and practical work. The surgeon's craft was no longer an empirical accomplishment to be practised by an unlettered journeyman or barber. In his school at the Jardin du Roi, Pierre Dionis had pointed the way, eagerly followed by Jean-Louis Petit in the Collège de S. Côme: a deeper knowledge of anatomy *as applied to the art of surgery* was to be the foundation stone of the surgeon's training. In that path Dease and Colles followed faithfully. Their anatomy was not that of Vesalius with its wholly systemic approach; nor had it the philosophic, comparative purpose of the biologist, John Hunter. Our Dublin anatomists were men of more pragmatic mould. Practical and practising surgeons all, they taught a surgeon's anatomy—the anatomy which to-day is called " applied." Colles was the first in the English-speaking world to place the French method clearly before his fellow-teachers in his *Treatise on Surgical Anatomy* (1811). To that small book, so highly praised by D'Arcy Power, Arnold Henry's artistic *Extensile Exposure* (1945) stands in the direct line of succession.

Their surgery was a mechanical art, based wholly on their knowledge of anatomy as applied to their art. The scope of their practice was limited by necessity. They treated injuries, wounds, fractures, dislocations and broken skulls; they excised superficial tumours, and applied strong nitric acid to piles. The " capital " operations—those which bore the most immediate risk of fatality—included the release of the strangulated hernia, the ligation of the larger arteries for aneurysm, and lithotomy. To the surgeon in every hospital was allotted the care of " the venereal " and, up to the time of Richard Bright's recognition of nephritis (1827), any and every discomfort associated with the act of micturition.

I believe I may safely boast that I have read every surgical paper published in Dublin in the first half of the nineteenth century. The use of the trephine figures largely in these surgical records. Not the least interesting was the discovery of the medico-legal point that a verdict of murder from a blow on the head was not considered tenable by the Irish judiciary of the day unless the skull of the deceased could be shown to have been fractured. It was a useful point for the defence in days when shillelagh-fighting ranked with cock-fighting as a national pastime! Formal indications for trephining were usually accepted as two—namely, depressed fracture and extradural haemorrhage. In the fully conscious patient, one observer records, " it is a dread ordeal, cruel and fearful to behold." Another recommends that the patient should be seated in a chair for the operation; then follows the purest gem of understatement I have ever read: " In general, if the patient be not unruly, two assistants will suffice."

Ever conservative in his patients' interest, Colles used to warn his students that they should be cautious in the use of the trephine. " The depressed fracture," he stated, " will often recover, although epilepsy may be the consequence later." Therein he anticipated Hughlings Jackson's observation by more than forty years.

Yet, under necessity, he could be prompter than his fellows. Lecturing on strangulated hernia he made this assertion: " One thing is certain: the result of the French rule of operating within twenty-four hours after its occurrence is infinitely more successful than ours who wait longer. If the operation is necessary the sooner it is done, the better."

The treatment of hydrocele in those days was an expensive procedure, doubtless reserved for private patients. Here is Colles's recommendation: " You inject the hydrocele, after tapping, with as much port and water as will equal the quantity of serum you let out, or nearly so. This should be retained in the tunica vaginalis till the patient gets faintish, and then withdrawn. Then keep the patient in bed for ten to twelve days, and he is ultimately perfectly well, as far at least as the hydrocele is concerned."

This treatment Colles had learned from John Collins Warren, the founder of the Massachusetts General Hospital. Among Colles's papers I found a note from Warren which

carries so much alcoholic content that I cannot refrain from quoting it in full: "This gentleman's hydrocele was large enough to hold a quart of water, too hard to distinguish the testicle, and perfectly opaque. He had been told that injection was the proper mode of operating and he wished me to practise it, which I therefore did. The fluid of the hydrocele being discharged by trochar and cannula, near a quart of port wine and water was injected without causing pain. No pain being brought on, a pint and a half of brandy, with two drachms of the sulphate of zinc, was injected. This caused a little pain, and the injection having been thrice practised, I would not proceed with it."

The patient, one is not surprised to learn, had a little fever the next day, with a swollen scrotum, but eventually made a satisfactory recovery. Poor Gibbon, the historian, one recollects, after a "life of autumnal felicity," had a much less happy close following the aspiration of his hydrocele.

Lithotomy was then the crucial test of the surgeon's skill. Daunt and Dease were eighteenth century lithotomists of repute, their expertise acknowledged as far afield as London and Paris. Here, too, Colles showed the hand of the skilled workman, using but three instruments—a scalpel, a grooved staff and a forceps. Emphasising the need for constant practice if one was to acquire the requisite manual skill, he used to tell a tale of his old master replete with sly, but kindly, humour: "Old Mr Dease was in the habit of constantly performing the motion his hands would take in this manoeuvre; even at the dinner table, while speaking to someone, he might be often detected moving his knife and fork as if pushing the scalpel and staff on together, without thinking of what he was doing."

Sir D'Arcy Power has credited Colles with having ligated the innominate artery. On this clue I searched all available records for Sir Gordon Gordon-Taylor, but could find no record of his ever having done so. He ligated the first stage of the subclavian on two occasions, in 1811 and 1813, both patients succumbing to post-operative infection later. With characteristic honesty he recorded his experience in detail (1815) so that "every one who reads these accounts should be unbiassed in drawing his own inference from the facts." His record concludes with his courageous reflection: "Although this operation has not yet proved ultimately successful, yet I think we should not despair. The history of surgery furnishes parallel instances of operations now generally adopted which, in the first few trials, failed of success." He lived to see his words come true.

Though Dease had been the founder of the School, Colles raised its reputation to the heights. He was in no sense a dashing figure. Of "about the middle size," he had what Aubrey called "a good Eie," grey in colour and given to easy twinkling with quiet humour. He was a shrewd, kindly man, deeply attached to his own fireside and utterly absorbed in his work. For over thirty years as Professor of Surgery he held the students' unbounded confidence as no other teacher in Dublin could do (Kirkpatrick 1924). Two things above all they prized in him—his truthfulness and his honesty. The man who did not hesitate to tell them: "Gentlemen, it is no use mincing the matter; I caused this patient's death" was imbued with a scientific humility rare in his or our generation.

He died the undisputed head of his profession, having twice refused a baronetcy. He had well merited such distinction, but, the simplest of men to the last, declined it.

REFERENCES

BRIGHT, R. (1827): Reports of Medical Cases, Selected with a View of Illustrating the Symptoms and Cure of Diseases by a Reference to Morbid Anatomy. Two volumes. London: Longman.

COLLES, A. (1811): A Treatise on Surgical Anatomy. Dublin: Gilbert and Hodges.

COLLES, A. (1815): Edinburgh Medical Journal, **11**, 1. *Reprinted in* Selections from the Works of Abraham Colles, Consisting Chiefly of his Practical Observations on the Venereal Disease and on the Use of Mercury. New Sydenham Society. Vol. 92 (1881). Edited with annotations by R. McDonnell. London: H. K. Lewis.

HENRY, A. K. (1945): Extensile Exposure Applied to Limb Surgery. Edinburgh: E. & S. Livingstone Ltd.

KIRKPATRICK, T. P. C. (1924): The History of Doctor Steevens' Hospital, Dublin, 1720–1920. Dublin: Dublin University Press.

HISTORICAL SURGICAL INSTRUMENTS IN THE MUSEUM OF THE ROYAL COLLEGE OF SURGEONS OF ENGLAND (4)

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The instrument illustrated in Figure 30 is for closing recto-vaginal or vesico-vaginal fistulae, and is a modification of the original design invented by W. R. Beaumont in 1836. William Rawlings Beaumont (1803–1875), F.R.C.S. by election 1844, invented the instrument when in practice in London, and an account, with two figures, was published in the *London Medical Gazette* (1836–37). In 1841 he emigrated to Canada and settled in Toronto. A further note from the *Lancet* (1866) on this device is as follows: "*The Sewing Machine.* It may not be generally known, but the fact deserves to be recorded in the *Lancet*, that the principal of passing and arresting the thread in Singer's sewing machine was taken from an instrument invented by a distinguished member of our profession, Mr W. Rawlings Beaumont of Toronto, an honorary Fellow of the Royal College of Surgeons of England, who used the ingenious instrument for passing sutures in vesico- and recto-vaginal fistula. Singer took his idea from Mr Beaumont's instrument exhibited in the shop of Freeman, a surgical instrument maker in New York." This statement, however, is not confirmed by the *Encyclopaedia Britannica* (1929) in the article on "Sewing Machines." Beaumont also designed a vaginal speculum and polypus snare, examples of which were in the war-destroyed Gynaecological Series of Instruments.

FIG. 30
Beaumont's instrument for closing recto- and vesico-vaginal fistulae (1836).

In 1920 Sir Rickman J. Godlee presented the tracheotome designed by Sir Henry Thompson (Fig. 31) illustrated in the *Lancet* in 1853. "The instrument which I have designed, with the assistance of Messrs Weiss, . . . consists of a broad pair of forceps, (something like ordinary dissecting forceps) but of which a portion of each extremity, about one inch and a half in length, forms an angle with the handle. The points of them meet accurately, so as to form, as it were, one blade together." This tracheotome was once the property of Lord Lister, a fellow-student of the inventor, and the donor believed that Sir Henry Thompson gave it to Lister before he went to Glasgow.

FIG. 31
Tracheotome designed by Sir Henry Thompson (1853).

Figure 32 shows the original set of tracheotomy instruments made for Mr Arthur Durham, F.R.C.S. (1833–1895) by Messrs Meyer and Meltzer before 1869. Durham contributed to the *Practitioner* (1869) a paper entitled "On some of the Difficulties and Dangers of Tracheotomy, and the best means of obviating them, with a Description of a New Form of Tracheal Canula." The case bears on the outer surface of the lid a blank

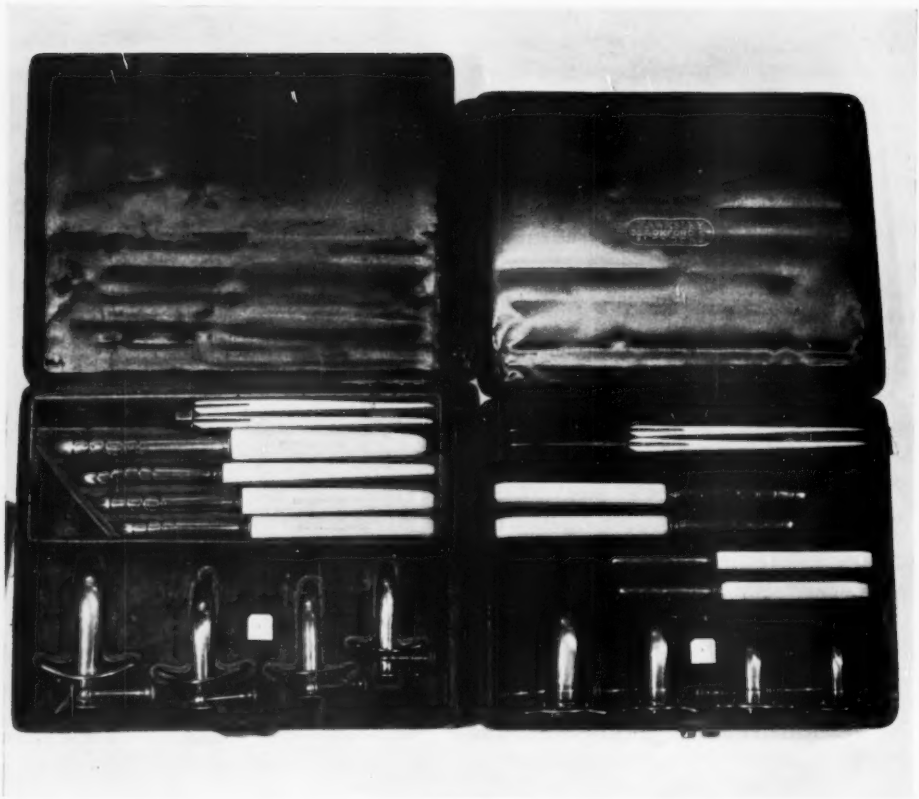

FIG. 32
Durham's instruments for tracheotomy (*left*) and laryngotomy (*right*) (*circa* 1866).

metal plate and stamped on the leather in gold is the lettering " 4 Tracheotomy Case—B—Durham " and the initials " A. E. D." in black lettering within an oval border.

Another case of Durham's instruments, for laryngotomy, and used by the inventor, is also seen in Figure 32. The instruments were used in the cases reported in two papers:

FIG. 33
Tracheotomy instrument designed by Dr C. Edwards (1853).

" Cases of Operations on the Larynx " published in *Guy's Hospital Reports* in 1866; and " On Opening the Larynx by Section of the Cartilages, &c. in order to facilitate removal of Morbid Growths " (*Medical and Chirurgical Transactions* 1872). In neither of these papers is there a drawing or description of the instruments.

Dr Charles Edwards, F.R.C.S. (died 1887) presented in 1876 a modification of his tracheotomy instrument (Fig. 33) with the note: " It is admirably applicable to any part of the trachea, which can by it be drawn forward, fixed, and immediately pierced by a straight bistoury, thus preventing all deep dissection and obviating the trouble of the occasional

FIG. 34

Left—H. O. Thomas's three-way aspirator (in case) and reservoir subcutaneous syringe.
Right—Pewter enema syringe which belonged to P. J. de Loutherbourg.

up-and-down movements of the trachea while operating." He described it originally in " Practical Observations on Tracheotomy above the Thyroid Isthmus " (*Lancet* 1853).

In 1915 Sir Robert Jones presented a three-way aspirator, stomach and enema pump (Fig. 34) with a note: " Aspirator in mahogany box, property of the late H. O. Thomas, Esq." This appliance, or at least the box, was made by Mr H. Owen Thomas himself, and is figured in Part I of his *Contributions to Surgery and Medicine* (1883), as " Three-way Aspirator,

FIG. 35
Bond's oesophageal forceps, specially made for removal of impacted foreign body.

Stomach and Enema Pump." In 1918 Sir Robert Jones also presented Thomas s reservoir subcutaneous syringe (Fig. 34) with a note: "Large hypodermic syringe, property of H. O. Thomas, Esq., carried about when visiting cases of intestinal obstruction."

In 1916 Dr G. P. Shuter presented a pewter enema syringe (Fig. 34) with a note: "Two old pewter enema syringes with date about 1800 have come to me. They belonged to De Loutherbourg, who was a popular Court Academician, scene painter to Garrick at £500 a year, and notorious in his old age for his belief in faith-healing and mesmerism, and for his practice of this form of quackery on other believers." Phillippe Jacques de Loutherbourg, R.A. (1740–1812) is buried in Chiswick Churchyard near Hogarth. Only one of the pewter syringes (of one pint capacity) was retained for the College Museum.

An instrument of unusual interest is Bond's oesophagus forceps measuring seventeen inches in length, which was specially made for the removal of an impacted foreign body (Fig. 35). The case was fully reported by the donor, Mr Thomas Bond, F.R.C.S. (1841–1901) in the *Lancet* of 1869, under the title "A Case in which a Brace-buckle was swallowed, and impacted in the Oesophagus fourteen days." To the forceps is tied the fellow of the brace-buckle and appended straps swallowed by the patient. After preliminary attempts to remove the obstruction Sir William Fergusson was consulted, and on the eighth day "used the forceps, and although meeting with much obstruction, boldly passed them into the stomach, causing however, such intense spasm and pain that it was impossible to make a very careful exploration, so that he was unable to feel any hard substance." Two weeks later Fergusson passed a whalebone probang, with an ivory knob at the extremity about the size of a pigeon's egg, and at once determinedly thrust it through the obstruction. This caused intense pain, but two hours later the patient took some beef-tea and, though very sore, felt no obstruction in swallowing, and three days later all pain had ceased. The patient was in perfect health over three months after the disappearance of the signs of obstruction, but although closely watched for some time, no foreign body had been passed from the bowel. In the fifth edition of his *A System of Practical Surgery* (1870), Sir William Fergusson related this case, adding "there had been no further knowledge of either strap or buckle."

Mrs Long, widow of William Long, F.R.S., Master of the College in 1800, presented in 1818 an instrument which has been described as "Pott's Guarded Fistula Knife" (Fig. 36). It consists of a curved sharp bistoury with a probe-pointed guard made to slide along its back, and a handle of two tortoiseshell scales into which the knife is folded when not in use. Pott's knife has a probe point and no guard. It is suggested that the sharpening of the point of the knife and the addition of a probe-pointed guard may have been introduced by William Long himself.

FIG. 36
Guarded fistula knife which belonged to William Long, F.R.S., Master of the College in 1800.

REFERENCES

BEAUMONT, W. (1836–37): Instrument for Closing Recto-vaginal or Vesico-vaginal Fistulae. London Medical Gazette, **19,** 335.

BOND, T. (1869): A Case in which a Brace-buckle was Swallowed, and Impacted in the Oesophagus Fourteen Days. Lancet, **i,** 671.

DURHAM, A. E. (1866): Cases of Operations on the Larynx. Guy's Hospital Reports. Third Series, **12,** 540.

DURHAM, A. E. (1869): On Some of the Difficulties and Dangers of Tracheotomy, and the Best Means of Obviating them; with a Description of a New Form of Tracheal Canula. Practitioner, **2,** 212.

DURHAM, A. (1872): On the Operation of Opening the Larynx by Section of the Cartilages, etc., for the Removal of Morbid Growths. Medico-Chirurgical Transactions, **55,** 17.

EDWARDS, C. (1853): Practical Observations on Tracheotomy Above the Thyroid Isthmus: with a Case Operated upon for Epilepsia Laryngea. Lancet, **i,** 492.

ENCYCLOPAEDIA BRITANNICA (1929): Sewing Machines. Fourteenth edition, **20,** 406.

FERGUSSON, Sir William (1870): A System of Practical Surgery. Fifth edition, 568. London: Churchill.

LANCET (1866): The Sewing Machine, **i,** 302.

THOMAS, H. O. (1883): Intestinal Disease and Obstruction. Contributions to Surgery and Medicine. Part 1. London: H. K. Lewis.

THOMPSON, Henry (1853): Tracheotomy, with a New Method of Performing the Operation. Lancet, **i,** 219.

THOMPSON, Henry (1853): Additional Remarks upon the New Operation of Tracheotomy by Dilatation of a Small Incision. Lancet, **ii,** 5.

PROCEEDINGS AND REPORTS OF UNIVERSITIES COLLEGES, COUNCILS AND ASSOCIATIONS

GREAT BRITAIN

BRITISH ORTHOPAEDIC ASSOCIATION

ANNUAL MEETING

The annual meeting of the British Orthopaedic Association was held at the Queen Elizabeth Hospital, Birmingham, on October 23 and 24, 1953. Sir Reginald Watson-Jones was in the chair on the first day, and on the second day he was succeeded by the new president, Professor Bryan McFarland. Clinical meetings were held at the Royal Orthopaedic Hospital, the Birmingham Accident Hospital, and the Rehabilitation Workshop of Austin's factory.

For the first time in the history of the Association an instructional course in orthopaedic surgery was given on the day before the meeting. Lectures were given, with discussions and

Canon Green investing the new president, Professor Bryan McFarland, with the Badge of Office. *Left to right*—Lady Watson-Jones, Professor A. P. Thomson, Professor Bryan McFarland, Canon Bryan Green, Sir Reginald Watson-Jones, Mr Gordon Irwin, Professor Thomas Bodkin. (*Photograph by Roy Dixon.*)

questions and answers, on " Lesions of the hip joint in children," by Professor Bryan McFarland; " The biochemistry of bone," by Dr C. E. Dent; " Traumatic anatomy of various injuries in the acute phase," by Mr W. Gissane; and " The management of poliomyelitis," by Mr H. J. Seddon. The course was attended by more than one hundred young surgeons and senior orthopaedic registrars as well as by some of the fellows and members of the Association, and in the evening they all joined with their wives in an informal dinner party with dancing.

At the annual dinner Mr J. B. Leather made a very pleasant and comprehensive speech in toasting the guests, to which Professor T. Bodkin replied. Professor A. P. Thomson, in proposing the toast of the British Orthopaedic Association, after tilting gently at the Badge and Coat of Arms of the Association, went on to advise orthopaedic surgeons who had not already done so

to take their share in the academic and teaching responsibilities of university and hospitals. In his response to the toast of the British Orthopaedic Association, Sir Reginald Watson-Jones agreed that in some few cities in Britain the charges levelled by Professor Thomson were perhaps justified, but he urged that orthopaedic surgeons were not specialists and not just surgeons, but that they were indeed good doctors. They should of course share with others the duty of teaching students and of co-operating with other surgeons and physicians. In view of the firm collaboration that had developed between the British Orthopaedic Association and the Colleges and Universities of Great Britain it would be unfortunate if there were still any groups of orthopaedic surgeons who were failing in this respect—and if so it was to their own discredit. Canon Bryan Green then invested the new president with the Badge, and after expressing his thanks Professor Bryan McFarland paid a stirring tribute to the retiring president and to Lady Watson-Jones. He drew attention to the enjoyable and historic times the Association had experienced during Sir Reginald's period of office. He mentioned particularly the orthopaedic meeting of the English-speaking peoples in London in 1952, the creation and presentation of the presidential badges, and the institution of the Archives of Orthopaedics, designed and initiated by Sir Reginald. He said that among all the qualities that had made Sir Reginald and Lady Watson-Jones precious to the Association those of generosity and kindliness stood out far above the others.

The new president suggested that the Association seemed disposed to make a suitable presentation to the retiring president and his wife. This suggestion was unanimously endorsed.

Presidential address—*Sir Reginald Watson-Jones*, retiring president of the Association, reviewed the progress and development of the British Orthopaedic Association. He said that under a succession of distinguished presidents the Association had prospered and gained in stature. It had created strong ties between the orthopaedic surgeons of Great Britain, the Commonwealth countries and the United States of America. It had given strong support to the foundation of the New Zealand Orthopaedic Association and the South African Orthopaedic Association. With equal generosity from the United States and Canada it had secured the foundation of Travelling Fellowships for young orthopaedic surgeons between the United States, Canada and the British Conmomwealth. Through this Journal the alliance with all countries of the Commonwealth and the United States of America had been increased. The British Orthopaedic Association had also authority and responsibility in relation to the Colleges and Universities. In the Royal College of Surgeons of England two Senior vice-presidents had been orthopaedic surgeons; an orthopaedic surgeon had been elected president of the Royal College of Surgeons of Edinburgh; and in the University of London an orthopaedic surgeon occupied one of the Chairs of Surgery.

The Association, mindful of the value of tradition, had recently taken steps to stimulate interest in historical treasures of orthopaedic interest. A collection of such treasures had been inaugurated at a recent ceremony attended by executives of the Association, to be housed at the Royal College of Surgeons of England, where a selection would always be on view in the College Hall. Among the items of special interest were the percussion hammer used by Hugh Owen Thomas, his flute, his smoking cap, and the signet ring with which he used to seal the collar-and-cuff slings so that they would not be removed without his knowledge before the next visit.

Sir Reginald Watson-Jones said that during the term of his presidency much greater responsibility and authority had been placed upon the younger members of the Association; the young members had now almost as great an authority as the old fellows. But, he added, this responsibility must be accepted as a duty: " The younger members of the Association who now hold such authority must devote themselves to the cause we all have at heart—the advancement of orthopaedics and the relief of suffering, whether of the body or the mind; and moreover devotion is not enough—there must be dedication."

Acrylic replacement as the primary treatment of sub-capital fractures of the femur—*Mr A. D. Le Vay* (London) gave an account of his experiences with replacement arthroplasty of the hip by a prosthesis of the Judet type as the primary treatment of subcapital fractures of the neck of the femur. His results encouraged him in the belief that the method was well justified in the elderly. Most patients had been allowed up four to five weeks after the operation and the average length of stay in hospital was ten weeks. Mr Le Vay preferred a limited anterior incision and he liked to suture the capsule over the prosthesis: these details of technique reduced the risk of dislocation. Although there had been a tendency for the head to migrate into a varus position a point of stability was reached beyond which no further displacement occurred. Insertion of the prosthesis to lie in slight valgus offered advantages.

Mr O. J. Vaughan-Jackson (London) recalled that at a clinical demonstration at the combined meeting of the orthopaedic associations of the English-speaking World in 1952 he had shown elderly patients with fractures of the neck of the femur treated primarily by replacement

arthroplasty. Though privately optimistic he had at that time adopted a cautious attitude. A further year's observation of these patients and of others in his total series of thirty-four cases had confirmed him in his optimism, but it was still too early to make a final assessment of the merits of the operation. Its limitation was that at best it did not give a normal joint, which was not true of a successful nailing operation: it could therefore not be recommended for all patients with femoral neck fractures, certainly not for those in their fifties or sixties. Nevertheless he believed that it could be recommended for the really aged, for it avoided the uncertainties of the nailing operation, with the likelihood that a high proportion of patients treated by nailing would require further operative treatment later. Of his thirty-four cases, the operation was tolerated well in thirty-two and poorly in one; one patient died. The main local complication was fracture of the prosthesis, which occurred in four cases; the use of metal prostheses in place of plastic would probably solve the problem of breakage. Walking was resumed five to six weeks after operation. Most patients preferred to use sticks for at least six months but none complained of severe pain. *Mr G. N. Golden* (Guildford) reported sixty cases of Judet arthroplasty for fracture which he had reviewed in collaboration with *Mr C. C. M. Murray* (Portsmouth) and *Mr A. G. Ord* (Portsmouth). The results were good in 70 per cent and satisfactory in a further 15 per cent. He agreed that the operation offered advantages over nailing in the aged. *Mr K. H. Pridie* (Bristol) condemned the operation of primary Judet arthroplasty for fractured femoral neck. He recalled that in 57 per cent of cases in which treatment was by nailing, the hip was indistinguishable from normal. Avascular necrosis was inevitable in 11 per cent but this was balanced by a 12 per cent incidence of fractured acrylic prosthesis. Judet arthroplasty should be reserved for the treatment of fractures in which nailing had proved unsatisfactory. *Dr J. T. Scales* (Stanmore) said that further work was required on the properties of materials used for internal appliances. Plastics were liable to heat deterioration but metals were also liable to defects resulting from stress. *Mr A. C. Bingold* (Sidcup) had seen serious wear in an acrylic hip prosthesis. He believed that acrylic resin was unsuitable for the purpose. *Mr K. I. Nissen* (London) stressed the need for caution. He had been pleased to hear that acrylic replacement had been recommended only for the treatment of fractures in the aged.

The valgus foot—*Mr G. K. Rose* (Shrewsbury) said that the problem of the "valgus" or "pronated" foot was unsatisfactory. The dividing line between the normal and the abnormal was ill-defined, and the indications for treatment and for its cessation were indefinite. In order to determine the variations of normal he had undertaken a long-term investigation of the feet of 177 children aged between six and eight years. From prints of the feet obtained on special sheets he had formulated a "valgus index" based on the medial shift of the line of weight bearing from a standard axis; this had been correlated with the position of the knee as indicated by the patellar axis. His conclusions were that some valgus shift was normal, but that there was no difference in the valgus index between boys and girls. The significance of valgus shift was greatest when the axis of the knee was medial to that of the foot and least when the axis of the knee was lateral to that of the foot. The essential pathological feature in the abnormal valgus foot was strain of the peritalar joint, not simply an abnormal position of the joint.

Causes of coccydynia—*Mr H. J. Richards* (Oswestry) reviewed the possible causes of coccydynia in the light of a study of 102 cases. A history of injury was present in less than half the cases. Infection and neoplasm were occasional causes but could not explain the majority. Psychogenic factors were secondary rather than primary. He believed that in many cases coccydynia was caused by a central prolapse of one of the lower lumbar intervertebral discs. He supported this hypothesis on theoretical grounds and by clinical observation. Thus forty out of 1,000 patients diagnosed as having a disc protrusion complained of coccydynia in association with sciatic pain; and nearly half of the patients with coccydynia had initial low backache or sciatica and most of the remainder later developed similar symptoms. Many patients had gained relief from pain after immobilisation of the lumbar spine in a plaster jacket. *Mr K. I. Nissen* (London) expressed strong disagreement with the hypothesis presented. In his experience relief from coccydynia could nearly always be assured by repeated manipulation of the coccyx: excision might be necessary in 5 to 10 per cent of cases. He could not accept the argument that prolapse of an intervertebral disc played a direct part in the etiology. *Mr H. K. Lucas* (Bristol) supported the concept of root pressure as a cause of coccygeal pain. *Mr G. K. Rose* (Shrewsbury) had had success with the treatment of coccydynia by plaster jackets.

Fractures of the lateral condyle of the humerus—*Mr J. N. Wilson* (Cardiff) reviewed fifty-seven such fractures of the elbow in children with particular reference to the complications and treatment. He recognised three types: 1) the flake fracture in which a thin piece of bone was detached from the bony nucleus of the capitellum; 2) the type in which a large fragment was avulsed; and 3) the

fracture with subluxation of the elbow joint. The following complications were observed. Limitation of movement—this was uncommon. Deformity—cubitus valgus was less common than might be thought. " Fish-tail " deformity of the lower end of the humerus might predispose to osteoarthritis. Ulnar neuritis—this was a recognised complication but he did not accept that it was caused by cubitus valgus alone: he believed that a coincident deformity in the region of the medial epicondyle was responsible. Non-union—only one case was observed. The cause was uncertain; it was not due to avascular necrosis, but progressive forward displacement of the separated fragment might be responsible. Loose body—chipped-off fragments might lie loose in the joint. In treatment, conservative methods were usually successful. If the fracture was irreducible or unstable operative reduction was required. After accurate reposition of the displaced fragment fixation was secured by a Pidcock pin. *Professor Bryan McFarland* (Liverpool) advocated a cautious attitude towards the immobilisation of injured elbows in plaster. He agreed that late ulnar palsy was not caused by deformity alone. He ascribed it to an irregularity of the shape of the medial condyle secondary to the distortion of growth at the lateral side. *Mr O. J. Vaughan-Jackson* (London) said that the irregularity might not always be bony: a collection of " pin-head " ganglia could be sufficient to impair the function of the nerve.

Treatment of peripheral arterial disease—*Professor F. A. R. Stammers* (Birmingham) said that there were many points of common interest between orthopaedic surgeons and vascular surgeons. He recalled that sympathectomy was first done for vascular disease by Adson at the Mayo Clinic; it had been done previously for spastic conditions, and it was the observation that the limbs became more warm and dry after sympathectomy that led to its trial use in vascular disease. The vascular conditions that might be benefited by sympathectomy could be classified under five headings: 1) those from spasm—impaired circulation after poliomyelitis; acrocyanosis frigida; Raynaud's disease; 2) those from such anatomical abnormalities as cervical rib; 3) those from disease of the arterial wall with superimposed spasm of varying degree—Buerger's disease; endarteritis; medial sclerosis; atherosclerosis; 4) conditions caused by embolism; and 5) conditions caused by injury. Sympathectomy could be of benefit only in so far as it relieved the element of the obstruction that was caused by spasm. The initial symptom of circulatory impairment might be trophic change or deficient healing after minor injuries (for example, after poliomyelitis) or intermittent claudication in the calf or extensor groups of the leg or in the thigh muscles. In the investigation of such cases a detailed history was important. A study was required of the peripheral pulses and of the response of the peripheral circulation to general body heating or to sympathetic block. Arteriography was helpful and was of increased importance in view of the recent development of the grafting of stored arteries. In the treatment of peripheral circulatory impairment the first aim was to remove spasm and promote development of the collateral circulation. Smoking should be absolutely prohibited (not just reduced), but alcohol was beneficial. Reflex vasodilation by general body heating was a useful method of treatment. Buerger's exercises and antispasmodics were worth a trial. Operation should be considered when conservative measures were ineffective. In general, lumbar sympathectomy was more successful and more permanent than cervical sympathectomy. Severance of the tendo calcaneus in the treatment of intermittent claudication was of use only in the elderly: it converted a painful hobble to a painless shuffle. Artery grafting was a relatively new technique with interesting possibilities. The ultimate fate of arterial homografts required further study: in some of the early experimental studies in animals the grafts had shown aneurysmal dilation.

Discussing individual conditions, Professor Stammers said that vasospasm after poliomyelitis was probably related to the deposition of fat rather than to the extent of the paralysis. It responded well to sympathectomy. Acrocyanosis presented a similar problem, but the ulceration of Bazin's disease, which was tuberculous in nature, was not improved by sympathectomy. When vascular symptoms complicated cervical rib the subclavian arch was usually found to be high; scalenotomy (Adson) often gave relief. In dealing with acute vascular crises every means of securing relief of vascular spasm should be tried in the first hours, but if the response was unsatisfactory the affected vessel should be exposed by operation in an attempt to restore its patency by bathing with papaverin or by vein or artery grafting. In axillary arteritis from the prolonged use of crutches the brachial vessel was blocked by thrombosis; there might be limited gangrene but conservative treatment was often adequate. In cases of acute embolism embolectomy could be effective only if done within three hours of the onset of symptoms.

Muscle resistance to stretch in the early stages of poliomyelitis—*Mr G. P. Mitchell* (Oxford) recalled that much attention had lately been directed to the problem of muscle " spasm " in the early stages of poliomyelitis. There were divergent views as to its cause, nature and importance. His own observations were that there was no true spasm except in the spinal muscles during the

stage of meningeal irritation. In the limbs, limitation of passive movement was the consequence not of true spasm but of the resistance of muscles to stretch. The movements that were most restricted were those that caused traction on the main limb nerves, and if the liability to traction was increased by changes of posture—such as lateral flexion of the neck to the opposite side in cases of restricted elbow extension—the resistance to stretch was increased. Muscle resistance to stretch was simply a guarding action to prevent traction on the limb nerves. These points were demonstrated convincingly in a ciné film. *Professor J. Trueta* (Oxford) considered that the observations that had been presented provided an entirely satisfactory solution to the hitherto baffling problems of so-called muscle spasm in poliomyelitis. *Mr Norman Capener* (Exeter) had found that the muscles that caused most difficulty from resistance to stretch were those such as the gastrocnemius that acted over two joints.

Development of congenital dislocation of the hip—*Mr E. W. Somerville* (Oxford) submitted a new hypothesis based upon previously recorded facts, his own observations on cadavers of newborn infants, and on a series of forty-one patients treated by operative reduction. He believed that the main factor responsible for the initial subluxation (which later progressed to complete dislocation) was anteversion of the femoral neck in consequence of which the femoral head exerted pressure upon the anterior part of the capsule when the limbs were extended after birth. (Pressure was least while the limbs remained flexed, so that dislocation before birth was unlikely.) If the capsule stretched under this pressure the femoral head was extruded from the front of the joint and lay at first antero-superiorly on the ilium. There it was so placed that the trochanteric region, by pressing upon the fibrocartilaginous limbus of the acetabulum, turned it over into the joint, where it occupied the supero-posterior part of the cavity and formed the chief obstacle to complete reduction of the dislocation by manipulation. In every patient operated upon he had found the limbus inverted as described, and he had succeeded in producing an identical inversion of the limbus experimentally in a cadaver. His plan of treatment—which was still on trial and was not yet advocated for general use—was to remove the inverted limbus, thereby allowing complete reduction of the dislocation, and subsequently to do a rotation osteotomy of the femur to correct the anteversion and thereby prevent recurrence of the dislocation. The stage of unrestricted walking was reached within four months of the beginning of treatment. So far, the results were promising. *Mr H. J. Seddon* (London) could not readily accept the hypothesis that the limbus played such an important part. He advised a cautious approach to open operation for congenital dislocation of the hip, recalling that a recent review of a large series of cases treated conservatively had shown that in half of them good clinical function had been retained for thirty to fifty years. He preferred to rely upon conservative treatment so far as possible, but its limitations should be explored; operation should be reserved for cases that were unsuitable for conservative treatment. *Mr J. R. Hughes* (Wrexham) was surprised that the limbus was a large enough structure to obstruct reduction. Possibly it became hypertrophied after it had become inverted. He agreed that anteversion was an important factor. *Mr G. C. Gordon* (Keswick) recalled that joints were formed at the eighth week of intra-uterine development. Therefore dislocation could occur at any time after that period. He showed radiographs of a congenitally dislocated hip in a foetus at the twenty-eighth week of gestation. *Mr H. Osmond-Clarke* (London) said that this was the first new and constructive contribution on the problem of congenital dislocation of the hip that he had heard for many years. Mr Somerville (replying) argued with effect that if orthopaedic surgeons were to be content with good functional results lasting about twenty or thirty years in only half the cases, they were setting themselves a very low standard. Anatomical results must be considered as well as functional results. Most patients would go for many years without symptoms; but the aim should be to strive for anatomical perfection and permanent relief.

Iso-nicotinic acid hydrazide (" Isoniazid ") in the therapy of bone and joint tuberculosis—*Mr A. G. Quinlan* (Oswestry), opening a symposium, reviewed the results of the use of iso-nicotinic acid hydrazide in the treatment of twenty cases of skeletal tuberculosis (mainly of the spine, hip, and knee joints). Treatment was continued for six months and no other anti-tuberculous drugs were given. His conclusions were that the drug caused marked improvement in the patient's general condition but had no dramatic effect upon the tuberculous lesion.

Dr F. Harwood Stevenson (Stanmore) recalled the laboratory and clinical observations that formed the basis for the use of iso-nicotinic acid hydrazide in tuberculosis. *In vitro* the drug had an antibiotic effect against the tubercle bacillus, which was even greater than that of streptomycin. Resistance of the bacilli against the drug developed rather rapidly, as it did against streptomycin. When given together, streptomycin and iso-nicotinic acid hyrdazide retarded the development of resistance by bacilli, provided the organisms were sensitive to both drugs; and the antibiotic effect of both drugs given together was greater than that of either given alone. Iso-nicotinic acid hydrazide

had the additional useful property of penetrating to reach the intracellular tubercule bacilli. Clinical observation in cases of pulmonary tuberculosis had shown that improvement occurred with iso-nicotinic acid hydrazide alone, but resistance soon developed in the tubercle bacilli and the clinical condition thereafter deteriorated. When iso-nicotinic acid hydrazide was used with streptomycin the results were better and resistant strains developed less rapidly. Dr Stevenson concluded that streptomycin, para-amino-salicylic acid (P.A.S.) and iso-nicotonic acid hydrazide should always be used together to minimise the development of resistance in the tubercle bacilli. In most cases treatment should be prolonged for six months but the dose of streptomycin might have to be reduced in the second three months.

Mr M. C. Wilkinson (Black Notley) had studied the synovial membrane of tuberculous joints after treatment by streptomycin in some cases, and by iso-nicotinic acid hydrazide in others. There was evidence that after streptomycin therapy healing was by fibrosis. He had hoped that iso-nicotinic acid hydrazide might permit healing of the synovium without fibrosis, for others had observed that effect experimentally in certain renal lesions. But a study of the synovial membrane of a shoulder joint after two months' treatment with the drug showed evidence of persistent tubercles. Possibly two months was too short a period of treatment, but his impression was that iso-nicotinic acid hydrazide alone did not lead to dramatic improvement of the local lesion, and he preferred to combine antibiotic therapy with excision of the synovial membrane. Mr Wilkinson emphasised that despite the introduction of antibiotic drugs a course of constitutional treatment under the best conditions was still an indispensable part of the treatment of skeletal tuberculosis. *Mr M. B. Devas* (London) reported that ten patients with skeletal tuberculous lesions who had received antibiotic therapy with a combination of streptomycin, para-amino-salicylic acid and iso-nicotinic acid hydrazide for six months all tolerated the drugs well and in all cases the lesion was quiescent a year later.

Foot supports—*Mr Norman Capener* (Exeter) outlined the work of the sub-committee of the British Orthopaedic Association formed to study surgical appliances and splints. Much discussion, he said, had centred on the problems of standardisation, but the sub-committee had upheld the principle that surgeons should have unfettered freedom in prescribing whatever appliances they wanted. Nevertheless it had been possible to standardise certain parts of appliances—especially of calipers for short-term use—without infringement of this essential freedom. Referring to foot supports, Mr Capener said that the sub-committee had felt anxiety at the promiscuous dispensing of foot supports "over the counter." When they were required for feet that were structurally abnormal, supports should be made individually from plaster casts of the feet. When the feet were structurally within normal limits he doubted the wisdom of prescribing foot supports at all.

Scoliosis: operative correction of fixed curves—*Mr F. G. Allan* (Birmingham) described a new method of correcting scoliotic curves. In principle, the method consisted in the use of an extensible jack operated by a screw mechanism. Each end of the jack was designed to fit into the side of a vertebral body at its junction with the transverse process. The jack was so placed that it bridged the primary curve on its concave side. When in position it was extended by screwing the centre-piece with a tommy-bar, thereby reducing the curve. Later, a segment of the spine was fused by bone grafts. The method offered the advantages that no plaster fixation was needed before or after operation, and that the time occupied by treatment was much reduced when compared with the technique of correction by hinged plaster jackets. Moreover it had been possible to correct curves that looked incorrectable by ordinary methods. In practice the operation had proved easiest in cases of lumbar and thoraco-lumbar curves. It was relatively difficult in thoracic deformity but the only complication of note had been pneumothorax from perforation of the pleura. This was no more than a preliminary report but so far results were promising. *Mr H. Osmond-Clarke* (London) welcomed the report as a likely step towards the solution of the problem of scoliosis, especially in younger children in whom the recognised methods of treatment were notoriously unreliable.

Primary dislocation of the patella—*Mr J. S. Ellis* (Southampton) believed that primary lateral dislocation of the patella was more common than was generally realised. It might explain some cases in which full function was restored after excision of a normal cartilage when the symptoms had been attributed erroneously to a torn cartilage. Only occasionally did the dislocation persist; usually spontaneous reduction occurred and the diagnosis was then difficult. The history might be like that of a case of torn medial cartilage, but on examination there was haemarthrosis (unusual in cases of torn cartilage), and the tenderness although on the medial side was not localised to the level of the joint line. A diagnostic sign was the pain reproduced by attempts to push the patella laterally. At operation, a rent in the capsule medial to the patella was to be expected. When the

condition was recognised soon after the injury, operative repair, with pleating of the medial part of the capsule, demanded consideration.

The treatment of dorsal adduction deformities of the fifth toe—*Mr W. H. Scrase* (Birmingham) reviewed the various methods that had been advocated for the correction of this common deformity, which he said caused symptoms in about half of all cases. Manipulation and splintage was time-consuming and seldom gave more than temporary benefit. Amputation was often unacceptable to the patient, and it might predispose to tenderness over the fifth metatarsal head which became prominent when the toe was removed. The technique described by Lapidus, which combined capsulotomy with transfer of the long extensor tendon to the plantar aspect of the phalanx seemed attractive but he had little experience of it. The method of skin advancement by V-Y-plasty was said to be successful but he had seen cases in which the deformity had recurred. The operation that he had used was " syndactilisation " of the fifth to the fourth toe. (The method was described by Professor Bryan McFarland in *Modern Trends in Orthopaedics*, edited by Sir Harry Platt, Butterworth 1950.) The extensor tendon was divided and the base of the proximal phalanx of the fifth toe was excised. The adjacent surfaces of the fourth and fifth toes were united after excision of a fillet of skin. The results were good in thirty-nine and fair in three of the total of forty-two toes operated upon. *Mr J. N. Wilson* (Cardiff) defended the operation of skin advancement by V-Y-plasty. Success depended upon a careful technique, and fixation in the corrected position in plaster was necessary for three weeks after operation. If these precautions were taken a good result could be assured. *Professor Bryan McFarland* (Liverpool) claimed a long experience of the " syndactilisation " operation which he had found satisfactory. He stressed the importance of excising the base of the proximal phalanx of the fifth toe to permit easy correction of the deformity.

Paralytic dislocation of the hip—*Mr G. Blundell Jones* (Exeter) described his experience of twelve patients, in seven of whom paralytic dislocation had been bilateral. The causes of the paralysis were spastic hemiplegia or paraplegia, poliomyelitis and meningomyelocele. In all of these patients, the onset of paralysis had been before the age of two years. In some cases paralysis of the lower limb had been complete. Mr Blundell Jones believed that the factor mainly responsible for the dislocation was an abnormal valgus position of the neck of the femur, which was often almost in line with the shaft. Adductor contracture was a contributory cause. After dislocation the acetabulum gradually became more shallow but it retained useful depth for several years. In early stages the dislocation could be reduced by simple traction and abduction of the limb, but it was likely to recur. Later, secondary contractures prevented reduction. When the dislocation was reducible it had been found possible to make the hip stable by wedge osteotomy at the base of the neck with restoration of the neck-shaft angle to 120 degrees. The fragments had usually been fixed after osteotomy by a small nail-plate. *Mr D. Le Vay* (London) preferred to treat dislocations of this type by a shelf operation, which had the advantage that it obviated shortening, preserved the efficiency of the abductor muscles, and did not endanger the blood supply of the femoral head. But *Mr Blundell Jones* (closing) did not accept these arguments: he had found the wedge osteotomy an easy operation whereas it was difficult to construct a satisfactory shelf in the correct position. He had not found that osteotomy at the base of the neck endangered the blood supply of the femoral head.

Clinical Meeting at the Royal Orthopaedic Hospital

A clinical meeting was held at the Royal Orthopaedic Hospital, the Woodlands, Northfield. Eighty patients were available for examination and were demonstrated by Messrs F. G. Allan, A. M. Hendry, T. S. Donovan, W. H. Scrase, A. C. Clark and J. A. Mantle (and on behalf of Messrs Wilson Stuart and J. B. Leather).

Operative cases included spondylolisthesis fused transabdominally, femoral and tibial lengthening, brachial plexus lesions, arthroplasties of elbow, bone-graft replacement of diaphyses and many cases illustrating the more routine work of the hospital. Bone diseases and tumours shown included actinomycosis and brucellosis of spine, endothelioma and osteoclastoma. Mr D. Barton of Walsall showed two cases of " short hamstring syndrome " treated by lengthening of the hamstrings.

Clinical Meeting at the Birmingham Accident Hospital

Mr William Gissane, welcoming members of the Association to the hospital, reminded them that they met in a building that marked an event of moment in medical education. Its foundation stone was laid in 1840, only a year after the opening of rival institutions in London (University College Hospital and King's College Hospital) and with them, this hospital, the old Queen's Hospital

of Birmingham, was the first of its kind expressly created to foster clinical instruction. Almost exactly a century later (1941) the Queen's Hospital as a general hospital was closed, and the last voluntary hospital in this country was established and named the Birmingham Accident Hospital.

Mr Gissane emphasised that the segregation of this reborn hospital away from the primary general and teaching purposes of its forebear was a force of circumstance—circumstance based primarily on hard financial reality, for the new Board of Governors could not see their way to finance a hospital serving more than the needs of accidents in this great industrial city; and the circumstance based secondly on the need for a fully organised accident service, to prove itself before it was accepted into the general hospital services. In the last decade there had been many changes, and the hospital had now developed sufficiently to inherit its place within the general hospital services as an intimate part of orthopaedic surgery.

The meeting had been designed to present a clinical approach to the surgery of acute injury to the locomotor system. Most of the injuries discussed were originally closed injuries, and the patients shown had all been treated by early open repair. The principle that was followed in the treatment of all injuries to the locomotor system was summed up in the dictum: " the repair must always be atraumatic." If divided tissues were reducible by closed methods, then closed manipulation was the routine method. When closed manipulation must fail to give the best functional result, then early open repair was very seriously considered. The decision on the appropriate method of early treatment was based on an understanding of the degree of division and displacement, not only of bone but of the closely related and equally important soft tissues. In all early open repairs the atraumatic approach could be followed only when the surgical exposure was over the area where the violence of the injury had already performed the deep dissection; by such an approach no additional tissues, other than skin and fascia, need be divided or detached by the surgeon.

Posterior fracture-dislocation of the hip—*Mr W. Gissane* illustrated the anatomy of several posterior fracture-dislocations of the hip. Open repair of this type of injury was indicated when, after closed manipulative reduction of the dislocation, large segments of the acetabular rim remained displaced. On posterior exposure of such hip joints the large bone fragment was demonstrated with its capsular attachments intact. It generally lay superficial to and above the pyriformis, which was interposed between the displaced fragment and the joint. Occasionally the fragment lay below and superficial to the more distal short rotators of the hip. On exact reduction and fixation of the displaced acetabular fragment, the posterior capsule of the hip joint fell into its normal position and it and the damaged short rotators could be easily repaired. Three patients were demonstrated. All had normal function.

Dislocation of the knee—*Mr W. Gissane* described the varied forms of traumatic anatomy of closed dislocations of the knee. In all cases both cruciate ligaments were divided, but the injury and displacement of other soft tissues around the knee joint varied. Sometimes the posterior capsule and muscles were torn and displaced and the quadriceps was left intact. Sometimes the quadriceps was widely torn and displaced and the posterior structures were left intact. The damage to the collateral ligaments and the semilunar cartilages was also variable. The exact repair of all divided tissues was advocated together with the removal of torn and displaced cartilages. Two patients were demonstrated.

Fractures of the lateral condyle of the humerus—*Mr F. G. Badger* demonstrated the anatomy and discussed the results of conservative treatment in a generally neglected type of lateral condylar fracture of the humerus in children. Two types of lateral condyle fracture in children were recognised. One could be called a " push off " fracture. It was caused by a fall on the outstretched hand. The force was transmitted up the radius, and the radial head seemed to " push off " the condyle. The soft-tissue damage was confined to the capsule and was not great. This type of lateral condylar fracture was well recognised and he had nothing to add to its treatment. The other, the neglected type, appeared to be a " pull off," or avulsion fracture. A small piece of the diaphysis, with the origin of a strong group of forearm extensors, was always attached to the capitulum. It seemed that the continued pull of these extensors almost always led to non-union of the fracture and often to an increase in displacement of an originally undisplaced fracture. For all lateral condylar fractures of this type, even those without displacement, he advocated early open repair, first by exact suture of the thick periosteum and then the repair of the torn muscle and fascial cuff. Over forty such repairs had been carried out and in all there were extensive tears of the soft tissues surrounding the fragments. Six patients with excellent results were demonstrated.

Mr J. Fairbank (Cambridge) said that he did not accept the avulsion or " pull off " theory as the cause of what must be a very unusual fracture. *Mr W. Sayle-Creer* (Manchester) asked how quickly

movement was regained after operation. *Mr Badger* replied that recovery of full flexion and extension often took as long as twelve weeks, but bone union occurred within four weeks, and function was good after six weeks.

Acromio-clavicular dislocations—*Mr J. S. Horn* described the stages of separation of soft tissues in acromio-clavicular dislocations. It seemed that the acromio-clavicular ligaments were torn first, and next the conoid and trapezoid ligaments took the strain and suffered various degrees of injury until they finally broke and fell apart; the strain then fell upon the deltoid attachment to the front of the clavicle and this was torn. Finally the trapezius split posteriorly, close to the level of the clavicle, as the clavicle assumed its typically high position.

For the lesser degrees of this injury Mr Horn advocated conservative treatment, but for the major degree, particularly in heavy workers, he advocated exact repair of all divided tissues. The violence of the injury gave the full deep dissection and the surgery of exposure required only an adequate skin incision. Repair of the conoid and trapezoid ligaments could be exact, but only when the deltoid was reattached to the clavicle and the trapezius repaired was reduction stable. In four of nine early open reductions he had observed the torn trapezius lying across the acromio-clavicular joint and so preventing closed manipulative reduction. *Mr John Charnley* (Manchester) criticised the ugliness of the scar after a large incision in this region and preferred a small incision that permitted the clavicle to be screwed firmly to the coracoid process. The screw was removed after six weeks. This operation left little or no scar—a matter of some importance in women—and in his experience was followed by good results. *Mr Philip Wiles* (London) said he was satisfied with the results of conservative treatment for all types of this dislocation.

Lateral rotation fracture-dislocation of the ankle—*Mr H. Proctor* described the hospital's experience over the last six years in the treatment of lateral rotation fracture-dislocations of the ankle. The injury was by far the most common type of all ankle fractures and dislocations. The extent of division of tissues in this fracture-dislocation had now been observed in 400 early open reductions. First, the violence caused tearing and division of the very strong anterior inferior tibio-fibular ligament. This was followed by a low oblique fracture of the fibula; and associated intimately with this fracture was an oblique fracture of the posterior margin of the tibia. These two fractures should be considered as one continuous oblique fracture. After these events the strong lateral wall of the ankle mortise lost its stability and the foot rotated easily in a lateral direction and the whole anterior capsule of the joint was torn, and the medial malleolus avulsed, or the short fibres of the medial ligament torn.

Closed manipulative reduction of this injury undoubtedly gave good results in a high proportion of patients. Yet this method could not guarantee to put a policeman back on his beat or a builder back on his job, for too often an apparently satisfactory manipulative reduction deteriorated and the talus shifted outwards again, resulting in a severe disability and ending, perhaps, in arthrodesis. For all workmen who required strong ankles to hold their jobs and for all who were young enough to enjoy full physical activity, early open reduction was advocated. The reduction of all tissues must be exact, and all loose bodies should be cleared from the joint and from the various fracture lines. The surgical approach was first over the lateral malleolus, which was the most open part of the fracture-dislocation wound. The fibula was first reduced exactly and held by wire suture; this pulled down the posterior marginal fracture and generally realigned the medial malleolus. If the stability of the ankle mortise was tested at this stage of the operation it was found still to be unstable. Stability was achieved only by holding the lateral malleolus firmly to the tibia by a screw. The tibio-fibular ligament and capsule were then repaired exactly. In only 10 per cent of the fracture-dislocations did the medial malleolus also require fixation, either by soft tissue repair or by screw. The screw in the lateral malleolus was removed after six weeks to enable it to regain its normal mobility. On analysis of the quality of the results it was obvious that they were exactly proportional to the accuracy of the initial open repair. Twelve patients were shown.

Degloving injuries of the lower limbs—*Mr Ruscoe Clarke* discussed the anatomy of major degloving injuries of the lower limbs, some extending from the mid-thigh to the ankle. The skin was often undermined over much more extensive areas than the clinical examination suggested. In addition the underlying enveloping fascia and intermuscular fascial planes were often extensively torn, so that many vessels, nerves and individual muscles lay quite free from one another; yet these structures were almost always intact and viable. The underlying bones were sometimes fractured. The detailed traumatic anatomy of many extensive injuries of this type was shown on slides, which revealed them as much more than a skin wound, in fact as wounds of the extremity as a whole. The violence causing such wounds was generally by the pneumatic tyres of motor vehicles, and such injuries were often associated with other injuries. Therefore, although the

initial operative treatment of such limbs was urgent, no repair that was very prolonged was indicated. Yet two essential matters required immediate attention. First, the surgical cleansing of the limb wound, and secondly, the replacement of something like normal physiological tension of the limb as a whole. In his experience the best method of achieving the second objective was to resuture the whole of the degloved skin back in position. He knew of no method of determining, at the acute phase of injury, which skin areas would certainly die, or which areas would certainly live. It was true that extensive areas of skin might die, but this in itself had no adverse general effect upon the patient; indeed the dead skin seemed to be an adequate temporary protective cover against infection. More important still was the observation that although the skin might die, the subcutaneous tissues might survive and give a satisfactory protective cover to underlying bone. All skin grafting that was necessary was undertaken from the tenth to the twenty-first day.

Six patients with extensive degloving injuries of the lower limb, some with associated fractures, were shown. All had remarkably good function.

Bacteriological techniques—*Dr John Bull, Dr E. Lowbury and Dr Elizabeth Topley*, of the Medical Research Council Unit attached to the hospital, demonstrated techniques used in the quick identification of the common infecting organisms in wounds, together with antibiotic sensitivity tests and the results of controlled trials both in prophylactic and therapeutic uses of various antibiotics.

Film—The meeting closed with a film showing the techniques used in the hospital in the dressing of minor and major wounds, both in out-patients and ward dressing stations. The film also illustrated the arrangement of the burns dressing station, in which bacteriologically clean air is continuously supplied. Since the introduction of this system the incidence of cross-infection during the dressing phase of extensive body burns had been dramatically reduced.

SPRING MEETING 1954

The Spring Meeting will be held at Buxton on May 6, 7 and 8, 1954. Visits will be paid during the meeting to Stoke-on-Trent, Derby and Biddulph Grange.

UNIVERSITY OF LIVERPOOL

LADY JONES LECTURE

The Lady Jones Lecture in Orthopaedic Surgery for 1953, entitled "Problems of the Development, Growth and Regeneration of Muscle," was delivered by Professor W. E. Le Gros Clark, M.A., D.Sc., F.R.C.S., F.R.S., on November 3 in the medical school of the University of Liverpool. The lecture was a comprehensive and stimulating review of the present state of our knowledge of the functional anatomy of muscular tissue; for example the power of regeneration of striated muscle, its relation to the vascularisation of individual muscles, and the similarity of the regenerative process to that occurring in peripheral nerves, were topics arousing great interest. It was evident that the results of minor muscle injuries and the mechanical effects of tendon transplantation should be considered more caretully in the light of recent findings in anatomical research. Indeed, it was obvious from the lecturer's lucid description of such researches that they materially assist the solution of clinical problems. This was an absorbing lecture, much appreciated by the crowded audience, and one which will be long remembered.

DEGREE OF M.CH.ORTH.

Eight candidates were successful in gaining this degree. They were:—

J. C. Anderson, Cape Town, South Africa;
M. Anwer, Lahore, Pakistan;
J. M. Gold, Edinburgh, Scotland;
J. Harari, London, England;
T. J. Mills, Armagh, Northern Ireland;
R. Owen, Liverpool, England;
F. W. Shea, Melbourne, Australia; and
G. A. Wetherell, Liverpool, England.

Mr Owen gained the Director's Prize for the best clinical performance in the examination and throughout the year. Owing to the careful selection of entrants to the course, there were no failures.

The external examiners were Professor Walter Mercer of Edinburgh and Mr H. Jackson Burrows of London. The internal examiners were Professor Bryan McFarland, Mr Norman Roberts and Mr Eric Wardle.

Cover of the menu-card—Robert Jones Dining Club—London—1953.

ROBERT JONES DINING CLUB—LONDON

The Robert Jones Memorial Lecture was delivered in the Royal College of Surgeons of England on December 10, 1953, by Mr St John Dudley Buxton who, as is customary, was thereafter the guest of honour at the Robert Jones Dining Club which is limited in its membership to the number of those who contributed to the Birthday Volume. The silent toast was drunk at nine o'clock precisely. A copy of the menu-cover, with its signatures of members of the club, is on the opposite page. Thereafter there was much happy debate, some bickering, and a great deal of goodwill, in trying to fill the two vacancies—every proposed member being quite inevitably black-balled as has happened almost invariably in the past. But a new system of election was devised—and, what is more important, a clerk to the club was elected. This office is now held by Sir Harry Platt, and we look to him for guidance in our future affairs. The promise of these endeavours is already evident in that a meeting of the Dining Club may be held in Liverpool this year, near to the date of Robert Jones' birthday, when there will be visits to the Hugh Owen Thomas and Robert Jones Library in the Liverpool Medical Institution, the Liverpool Cathedral where the ashes rest, and 11 Nelson Street.

Within the last few days Professor R. Merle d'Aubigné has accepted the invitation of the Royal College of Surgeons of England to be Robert Jones Lecturer for 1954, and in November the club will try to honour him at one of their most friendly dinners.

SCIENTIFIC SOCIETIES AND REGIONAL ORTHOPAEDIC CLUBS

THE BONE AND TOOTH SOCIETY

Bone and the Kidney: a Symposium

A symposium on " Bone and the kidney " was held at the Institute of Orthopaedics on October 20, 1953, with Professor W. D. Newcomb in the chair.

Tubule dysfunction with rickets—*Dr W. Sheldon* gave a general introduction with an historical review, and then spoke on rickets associated with tubule dysfunction: 1) vitamin-resistant rickets, 2) " Fanconi-de Toni " rickets, 3) infantile renal acidosis, and 4) juvenile renal acidosis. He drew attention to a syndrome comprising renal disease with mental defect, dwarfism, congenital heart disease, hypercalcaemia and craniostenosis; and also to a condition of defective ossification associated with deficiency or absence of serum alkaline phosphatase.

The clinical manifestations of kidney-parathyroid-bone relationship—*Dr F. H. Stevenson* discussed this, and considered the following illustrative syndromes. 1) Primary hyperparathyroidism: lowering of blood phosphorus, and increasing of urine phosphorus and of both blood and urine calcium by mobilisation of bone calcium. The latter caused bone pain and tenderness, bowing and fractures, and osteitis fibrosa generalisata. The hypercalcaemia could cause nephrocalcinosis or nephrolithiasis and, with infection, pyelonephritis. 2) Prolonged chronic renal insufficiency (usually due to pyelonephritis in adults, and to congenital renal tract malformations in children) caused secondary hyperparathyroidism from renal phosphorus retention. This in its turn caused the " hyperparathyroid " bone changes. In children these included a type of rickets, slipped epiphyses, genu valgum, dwarfism and infantilism, associated of course with the symptoms of renal failure but not usually with hypertension. 3) Acidosis, either secondary to chronic acquired renal disease, or associated with congenital tubule lesions of the Fanconi type, could increase demineralisation of bone by using the calcium reserves as a source of base for the urinary excretion of acid radicles. 4) Congenital renal tubule defects producing a high phosphate clearance, with or without glycosuria and high amino-aciduria, caused rickets or osteomalacia or both. 5) Calcium mobilisation from bone by other mechanisms than renal or parathyroid (for instance, immobilisation osteoporosis, or myelomatosis, or secondary malignant disease of bone) could produce renal lithiasis and consequent secondary renal changes.

Histology of bone disease with impaired renal functiom—*Professor S. L. Baker* described the bone changes in disturbed metabolism of renal origin as 1) retardation of growth as a whole, 2) rickets or osteomalacia, 3) osteitis fibrosa. " Renal rickets " often combined these three changes. It differed from nutritional rickets in that, being often of very long standing, it frequently showed secondary changes in cartilage and bone, and a secondary parathyroid hyperplasia with consequent osteitis fibrosa which might dominate the picture. Lantern slides were shown illustrating the histology of three cases of chronic renal disease with increasing azotaemia and phosphorus retention. The first showed rachitic changes with early osteitis fibrosa; the parathyroids were not enlarged

but showed a high proportion of vacuolated cells. The second showed healed rickets, marked osteitis fibrosa and great enlargement of parathyroids. The third showed gross deformities at cartilage-bone junctions, healed rickets, advanced osteitis fibrosa and great parathyroid hypertrophy. The normal course was for the rachitic changes to heal, because of parathyroid hypertrophy, with consequent increase in blood calcium and development of osteitis fibrosa. The speaker had not seen post-mortem material from Fanconi's disease; two biospies showed osteomalacia. As the condition caused a phosphate deficiency in the blood, rickets or osteomalacia would be expected; but if chronic nephritis developed later, with phosphorus retention, secondary parathyroid hypertrophy and osteitis fibrosa might be expected.

Normal renal functions that affect bone metabolism—*Dr C. E. Dent* said that normal calcification of bone occurred only if the interstitial fluids were sufficiently saturated with calcium and phosphate ions and if the pH was not below normal. (The former factor was roughly measured by the calcium-phosphorus product of the serum or plasma; this should be greater than 40, according to the " law " of Howland and Kramer. The pH was usually determined indirectly by measuring plasma bicarbonate levels which should be over 22 m.eq., granted normal respiratory function.) Disorders of kidney function could induce defective calcification by interfering with either or both of these mechanisms. Excessive loss of phosphate in the urine was the commonest immediate cause of rickets and osteomalacia. The patients had normal plasma calcium but constantly low phosphate and a normal bicarbonate. This occurred in vitamin-D deficiency and in a variegated group of congenital diseases usually but unfortunately classed as " vitamin-D resistant." With the diet usually eaten in this country, defective regulation of acid-base balance led to a chronic acidosis. The patients had normal plasma calcium levels, normal or low phosphate and constantly low bicarbonate while passing urine of pH above 6·0. These states were best described as " renal acidosis," and it was stressed that for some unknown reason renal acidosis usually occurred without bone disease. In some congenital diseases, such as the Fanconi syndrome, the kidney induced both defects, a chronic phosphate loss and an acidosis.

Estimation of kidney function—*Dr T. F. Dixon* described the methods of estimating kidney function used in the Metabolic Ward at the Royal National Orthopaedic Hospital. Tubular reabsorptions of calcium and phosphorus were calculated from twenty-four-hour excretions of these elements and inulin clearances. Vitamin D did not affect reabsorption of calcium but increased that of phosphorus. Phosphorus but not calcium clearances were increased with increased dietary intakes. Four cases of rickets associated with tubule dysfunction were cited, in two of which (Fanconi) amino-aciduria (mainly glutamine), hypercalcuria and glycosuria accompanied low plasma CO^2. In all, phosphorus reabsorptions were less than 1 milligram/min. compared with normal values of 4–5 milligrams/min. and all had serum inorganic phosphorus values below 2 milligrams/100 millilitres, normal serum calcium and raised alkaline phosphatase. It was suggested that these four cases presented varying degrees of tubular epithelium impairment consistent with the concept of a heterogeneous nephron population with representatives of all types ranging from those with good glomerular and tubular function to those with poor glomerular and tubular function.

SOCIETY FOR GENERAL MICROBIOLOGY

Serological testing for staphylococcal infection—At the meeting of the Society for General Microbiology at Glasgow on September 15, 1953, *Dr C. H. Lack* and *Mr D. G. Wailling*, of the Institute of Orthopaedics, London, presented their " Survey of 435 Strains of Staphylococcus phyogenes," obtained at the Royal National Orthopaedic Hospital. They were concerned with two problems: the factors responsible for invasiveness, and the development of a serological test for occult staphylococcal infection. Strains from osteomyelitic lesions, which were considered to be examples of invasive strains, showed a distribution of toxins very like that of strains in superficial infections, except that more were fibrinolytic. The authors were unable to demonstrate coagulase clotting *in vivo*, and suggested that in the body coagulase fibrin might be destroyed as fast as it is formed. The fibrin-clotting and fibrin-digesting mechanisms were shown to be so highly complex that it was not practicable to use the measurement of anti-coagulase or of anti-fibrinolysin as a serological test for staphylococcal infection. Anti-alphahaemolysin was a more straightforward test, but unfortunately about 20 per cent of strains did not produce alpha toxin, so that a negative titre did not rule out a staphylococcal infection. Other haemolysins produced by staphylococci were even less common. It was concluded that out of six staphylococcal products studied, coagulase was the only one invariably associated with pathogenicity, but, on account of the variables involved in the clotting process, its use as an antigen in serological tests could not be undertaken satisfactorily until purer fractions of coagulase, co-factor and fibrinogen were available.

SOUTH-EAST METROPOLITAN REGION ORTHOPAEDIC CLUB

A meeting of the club was held at the Royal East Sussex Hospital, Hastings, on September 26, 1953, when about thirty-five members and guests attended. The company was regaled with a wide variety of patients for examination and a radiographic demonstration.

Ankylosing spondylitis in young women—*Mr H. Bullen* showed two patients. The first, a woman now aged twenty-seven, had had bilateral sacro-iliac arthrodesis at the age of nineteen for suspected tuberculosis, which had not been proven histologically or bacteriologically. She had subsequently complained of pain and stiffness in the lumbar and thoracic regions from 1948 onwards. Her erythrocyte sedimentation rate remained consistently raised. Radiographs showed ankylosis of both sacro-iliac joints and suspicious changes in the thoracic and lumbar spine. Her posture remained good and she was kept in a surgical corset. In 1952 she had a baby and her pain practically disappeared during pregnancy; labour was uneventful. Early in 1953 the pain recurred and by now she had a completely rigid lumbar and thoracic spine, but had maintained an excellent posture. It was considered at the meeting that deep therapy was not at present indicated since her pain was not severe. Continued use of the spinal support was recommended because bony ankylosis did not appear to be complete.

The second case was that of an unmarried girl of nineteen who complained of sudden onset of pain in the right foot of one year's duration, with tenderness and puffiness over the tarsal joints. Later, pain started suddenly in the left sacro-iliac region, radiating to the sciatic distribution. At that time all movements of the left hip joint were limited and straight leg raising was moderately restricted on the left. Radiographs showed loss of definition in the left sacro-iliac joint but no abnormality in the hip joint, spine or feet. The erythrocyte sedimentation rate was 43 millimetres in one hour. She was admitted to hospital and kept at complete rest in bed. The sedimentation rate rose to over 50 millimetres in one hour during the subsequent five months despite complete rest in bed, and she now complained also of pain and stiffness in the left shoulder. The consensus at the meeting was that this must be a case of ankylosing spondylitis, but that deep x-ray therapy should be avoided if possible because of its effects on the genital organs. Immobilisation in a plaster bed was recommended, with care to maintain the mobility of unaffected joints.

Case for diagnosis—*Mr Bullen* showed a woman of thirty-one who complained for six months of pain in the left loin radiating to the left groin and anterior thigh, of gradual onset. An abdominal operation followed by pyelitis had occurred six months before the onset. There was also a previous history of right pes cavus as a child, treated by Steindler's operation; a slight limp and scoliosis had been noted since that date. On admission there were tenderness over the mid-lumbar spine and pain with all lumbar movements which were uniformly limited. Straight leg raising was restricted on both sides but there were no abnormal neurological signs. Radiographs showed a small destructive lesion in the upper part of the fourth lumbar body towards the left of the midline. Blood counts showed a slight polymorph leucocytosis and erythrocyte sedimentation rate varied around 50 millimetres in one hour. She was apyrexial and chest radiographs were normal. No abscess had manifested itself. It was agreed that this must be an infective lesion of the spine but that the differential diagnosis between tuberculosis and low-grade pyogenic infection was impossible at present.

Scavenging of the knee—*Mr Bullen* showed a woman of sixty-eight with a history of injury to the right knee in 1918 who complained more recently of sudden onset of pain in this knee with locking in flexion. Advanced osteoarthritis with loose bodies was demonstrated radiologically and the condition failed to respond to conservative treatment. "Débridement," so called, of the joint, including excision of the patella, was performed. Gradual improvement had resulted and when seen at the meeting she had full extension and 100 degrees of flexion movement. There was no effusion in the joint, which was painless. In discussion it was emphasised that the results of this operation are very variable but Mr Bullen was congratulated on the excellent outcome in this case. The operation had a definite place in the treatment of osteoarthritis but cases should be carefully selected after the failure of adequate conservative treatment. Several speakers remarked that an overlapping suture should not be used in the quadriceps tendon after excision of the patella. Such a suture always resulted in limited knee flexion and the quadriceps muscle was well able to take up the slack without shortening the tendon.

Tendon transplant for opponens paralysis—*Mr E. Bintcliffe* showed a girl of twenty-two who suffered from infantile paralysis in 1949, with residual paralysis of the opponens pollicis. At operation the extensor pollicis brevis tendon was separated from its muscle and passed through a subcutaneous tunnel across the palm and through a loop of flexor carpi ulnaris tendon attached

to the pisiform bone, beyond which it was anastomosed to the tendon of palmaris longus which had been separated from the palmar fascia. This operation produced a remarkably fine result and Mr Bintcliffe was able to report several other cases in which he had used the same operation with equal success. In discussion *Mr E. E. Harris* recorded that the flexor digitorum sublimis tendon of the ring finger could be used instead of palmaris longus with equally good results. It was emphasised that the loop of flexor carpi ulnaris tendon must be sutured back to the pisiform to provide a satisfactory pulley for the transplanted tendon.

Congenital club hand—*Mr E. Bintcliffe* showed a boy who had been under treatment since the age of six, with bilateral absence of the radius and thumb. Mr Bintcliffe outlined his method of treatment which had succeeded in producing considerable improvement in the deformity on the left side during the first year of treatment. A similar plan was later to be applied on the right side. First, skeletal traction had been applied to stretch the soft tissues on the radial side of the forearm for one month. Next, the shaft of the ulna was divided to correct as much of the bowing as possible. Finally, a bone graft consisting of the upper part of the fibula with its upper epiphysis was inserted into the radial side of the forearm and fixed to the midshaft and lower end of the ulna by two screws, the limb being then immobilised in plaster. It was hoped that the fibular graft would continue to grow from its epiphysial cartilage, but the lower end of the ulna had later been excised because its continued growth at a relatively rapid rate would otherwise probably throw the wrist into radial deviation. The possibility of a pollicisation operation was discussed but some members felt that a simple rotation osteotomy of the second metacarpal might suffice. The boy was already using his index finger as a thumb and even shortening of this digit after rotation might prove to be a disadvantage from a functional point of view.

Malignant synovioma of the foot—*Mr E. Bintcliffe* showed a woman of fifty-seven, who had noticed a small tumour between the first and second metatarsal heads for many years; it had increased in size for a short period before the patient's admission. On exploration the tumour was found to consist of soft greyish tissue, necrotic in its centre. There was no obvious capsule but careful dissection had apparently resulted in its complete removal. The histological report was that the tumour consisted of an innocent synovioma. Two months later, however, it became apparent that the tumour was recurring and a Lisfranc amputation was performed. Examination of the removed specimen now showed the structure of a malignant synovioma with infiltration of the muscles of the sole of the foot. The patient remained well with no sign of local or systemic recurrence of the tumour. The stump was functioning to the patient's complete satisfaction with the use of a modified shoe. Mr Bintcliffe pointed out that he would have performed a more radical amputation if the malignant nature of the tumour had been appreciated at the time of the second operation. Several other members recalled examples of this tumour, nearly all of which had proved to be malignant though some could quote long survival periods.

AUSTRALIA

AUSTRALIAN ORTHOPAEDIC ASSOCIATION

ANNUAL MEETING

The thirteenth Annual General Meeting of the Australian Orthopaedic Association, was held at Hobart, Tasmania, on September 8–12, 1953. The president reported with regret the serious illness of Mr Denis Glissan, a foundation member, and the deaths of Mr Alex Jouett and Mr William Herlihy. Mr H. R. T. Hodgkinson has been appointed Registrar of Rare and Interesting Diseases on the resignation of Mr H. C. Barry. The treatment of Pott's fracture and a study of end-results is the subject for the Australian Orthopaedic Association Prize Essay for 1954. The Association has had the pleasure of entertaining Dr Henry H. Kessler and Dr Joseph Barr of America. There are now ninety-four members of the Association, sixty-five being Active Members.

Mr Lennox Teece (Sydney) delivered his presidential address on " The Treatment of Relapsed, Resistant, and Neglected Cases of Congenital Talipes Equino Varus." He said that the completely neglected case was now rare, and most of the children with whom his paper was concerned were aged from three to ten years. Practically all had had some treatment of varying efficiency—gradual correction by manipulation, and retention by adhesive plaster, plaster-of-paris or Denis Browne splints; or multiple tenotomies combined with wrenching under anaesthesia. He regarded the case as " resistant " when such treatment had failed though persistently carried out. The ideal objective was complete permanent correction of each element of the deformity, with full mobility

of all joints; but in the cases under discussion this ideal was seldom possible. The patients needed operation; soft tissue, bony or both. Operation on bone should be reserved for those in whom growth in the deformed attitude had led to alteration in the shape of the bony components of the foot. Mr Teece described the extensive division of soft parts necessary to correct severe varus and forefoot adduction, laying particular stress on complete and careful division of the interosseous talo-calcanean ligament. Nearly always the correction of equinus should be left to a later stage. He warned that full overcorrection in the initial plaster was dangerous, as likely to obstruct the posterior tibial artery. It was his practice to change the plaster to gain full over-correction after three weeks, and at this stage lengthen the tendo calcaneus if necessary. In the all too common case with structural change in bone, some form of triple arthrodesis would ensure correction of varus and forefoot adduction, but equinus remained a difficult problem. In such cases he advocated division of the interosseous membrane together with an osteotomy of the fibula just above the malleolus to widen the tibio-fibular mortise. Finally Mr Teece stressed the necessity to keep all cases of equino varus under regular supervision until the age of ten years or alternatively for five years after the final correction of the deformity.

Scoliosis—*Mr W. F. Swaney* (Melbourne) referred to the method of measurement of the scoliotic curve introduced by Ferguson in 1930 and modified by Cobb in 1948, and to a paper by Ponsetti and Friedman in 1950 on prognosis in idiopathic scoliosis. By the methods of these authors he considered it possible to give a fairly accurate prognosis in which the important factors were: 1) the age of onset, 2) the curve pattern, and 3) the etiology. Careful early assessment could do much to spare from treatment patients whose deformity would never be severe. He stressed the poor results from exercises and jackets, and quoted figures of the Research Committee of the American Orthopaedic Association (1941): the curvature remained unchanged in 35 per cent of patients; increased 5–15 per cent in 34 per cent of patients; increased 20 per cent or more in 27 per cent; and improved in 5 per cent. He believed that management of scoliosis resolved itself into: 1) no treatment for those unlikely to develop a severe deformity, and 2) correction by turnbuckle jacket and spinal fusion in the 5 per cent in whom the curve will be severe, namely (*a*) those with curves greater than 70 degrees and severe clinical deformity, (*b*) those with early onset and poor prognostic pattern, (*c*) those with a collapsing paralytic spine, (*d*) very rarely those with a severe lumbar curve causing uncontrollable backache. Discussing methods of fusion, Mr Swaney said he preferred to operate through a window in the "Risser" jacket. The amount of curve to be fused was the primary curve alone. In the collapsing paralytic spine it was of the utmost importance to determine that the patient had adequate hip flexors. As to the age for operation he quoted J. I. P. James who rarely selected an earlier age than ten years.

Delayed union and non-union in fractures of the shaft of the femur—*Mr Douglas Sturrock* (Sydney) had found that usually failure of union had been caused by interposition of soft tissues. Non-union was considered to be present when there was free mobility at the fracture site and little or no radiological evidence of callus formation at the end of ten weeks. He was accustomed to approach the shaft of the femur from the postero-lateral aspect, lifting up the vastus lateralis muscle from the lateral intermuscular septum. After the fracture ends were freed, a V wedge was cut to expose the medullary cavity, the medial or posterior cortex being spared to preserve full length. He secured fixation by a long six-hole plate, and, in cases of established non-union, fixed a long, full-width, tibial graft to the lateral aspect with four screws. The V gap in the femur was packed with cancellous bone. Patients treated on these lines usually showed firm union at the end of about two months, when immobilisation was discontinued and Russell traction with knee movement was begun.

Changes in the hip joint in children suffering from cerebral palsy—*Dr Neville Wilson* (Adelaide) had observed in the radiographs of forty-nine patients: 1) normal hips in ten patients, 2) enlargement of the lesser trochanter in fourteen, 3) flattening of the roof of the acetabulum in three, 4) elevation of the distal component of Shenton's line without other evidence of subluxation in sixteen, and 5) subluxation of one or both femoral heads in six patients. There was often a combination of these anomalies. No changes attributable to osteochondritis were observed. The angle of the neck of the femur varied inversely as the greatest angle of hip abduction. Subluxation did not occur if the neck angle was less than 140 degrees. Twelve of the patients under review were bedridden. He regarded over-action of the iliopsoas and the adductor muscles as the important factor in causing changes in the architecture of the hip joints.

Recurrent dislocation of the patella—*Mr Franklin Stonham* (Melbourne) ascribed recurrent dislocation of the patella to several causes: 1) developmental abnormalities, often familial, with an abnormally small patella and imperfect development of the lateral femoral condyle, 2) genu

valgum, and 3) traumatic dislocation, with contracture and scarring on the lateral side of the knee joint. The clinical features were usually obvious to the patient, though sometimes the symptoms had been ascribed to a dislocation of the lateral meniscus, especially if subluxation was partial. In treatment, correction of the mechanics of the joint was the first essential. Knock-knee should be corrected and muscle tone in the quadriceps improved. A number of operations had been devised to realign the quadriceps. Medial reinsertion of the patellar tendon was probably the most popular, though various forms of plastic operations on the capsule and fascial slings had had their advocates. In post-traumatic cases he favoured a capsuloplasty resembling the Krogius procedure. Through a large incision the scarred mass of tissue connecting the patella to the lateral surface of the tibia and fibula was removed; often this involved opening the joint. Through a medial long parapatellar incision the capsule was amply plicated. Sometimes the lateral capsular wound could not be closed. Active movements were begun when the skin had healed. This operation had succeeded after transplantation of the patellar tendon had failed.

The surgical treatment of tuberculous joints—*Mr F. M. McC. Callow* (Sydney) recalled that for many years sound ankylosis of a tuberculous joint in good position had been regarded as the best result possible. The development of streptomycin, para-amino-salicylic acid and iso-nicotinic acid hydrazide had entirely altered the outlook. With their use, selected tuberculous joints could be treated in the same way as a joint infected with any other organism. Streptomycin allied with conservative treatment was ineffective in many tuberculous joints because of the characteristic obliterating endarteritis. Operation was designed to destroy the mechanical barrier, and, by causing hyperaemia, to allow the antibiotic access to the diseased area. Local streptomycin was used in the wound at operation, immobilisation was obtained by splintage, and parenteral antibiotic therapy was instituted. Graduated joint movement was begun as soon as evidence of joint inflammation had disappeared. He believed that, in tuberculous disease, bone repair would not occur in the presence of pus, and that all paravertebral abscesses should be emptied. The number of his cases was still too small for useful analysis; but he had seen tuberculous joints regain full movement when treated early, and an acrylic prosthesis had been put in a hip joint where previously an arthrodesis would have been the operation of choice. He considered that early operation in selected cases could reduce the duration of disability from years to months.

Osteoporosis—*Mr Esmond F. West* (Adelaide) said that in normal adult bone there existed a nice balance between formation and resorption. Osteoporosis was due to faulty deposition of protein, not primarily to a disturbance of calcium metabolism—serum calcium, phosphorus and phosphatase values were therefore normal in osteoporosis. He enumerated seven conditions presenting osteoporosis: 1) starvation, with deprivation of protein, 2) immobilisation, causing depression of osteoblastic activity, 3) post-menopausal state, in which a hormonal deficiency led to poor osteoblastic activity, 4) senility, 5) Cushing's syndrome, in which an excess of the adrenal cortical "sugar" or "S" hormone inhibits anabolism of protoplasm including bone matrix, 6) acromegaly, in which the cause may be the increase of pituitary hormone or the secondary lack of gonadal hormones, 7) idiopathic, in which the cause is unknown. Three types of osteoporosis were common in orthopaedic practice—senile, post-menopausal and that due to immobilisation. In the elderly, osteoporosis was much more frequent in women than in men, the proportion being about four to one. In the post-menopausal type there was often a story of vague backache for many months, with severe pain after a fall or relatively minor jolt. Radiography disclosed vertebral bodies of poor density and often with fish or hour-glass deformity; crush fractures were found in the mid-thoracic and upper lumbar regions. Fractures were sometimes the result of electro-convulsive therapy. Attention was drawn to diagnostic distinctions from hyperparathyroidism, multiple myelomatosis and secondary deposits from breast or lung cancer. In the management of post-menopausal osteoporosis it was important to maintain mobility. Fractures of the spine should be treated in a support, diet adjusted and glandular therapy prescribed. The occasional association of Paget's disease and osteoporosis was mentioned. In discussing osteoporosis of immobilisation in recumbency, Mr West concurred in F. H. Stevenson's assertion that premature epiphysial fusion was only one of the unfortunate skeletal consequences of immobilising the whole patient. Mr West concluded his paper with some brief case histories.

Bone infection: its problems and attack with special mention of streptokinase and streptodornase—*Mr Richard Hodgkinson* (Sydney) said that bone infection—whether haematogenous or due to local injury, surgical or accidental—remained one of the major orthopaedic problems, in spite of all advances in chemotherapy. He dealt briefly with methods evolved in two wars to deal with wound infection; and referred to Lady Florey's work on the results of "suitable surgery" combined with antibiotic therapy, and the role of gram-negative contaminants in delaying

healing. He quoted Buckman's results in infected wounds where, after adequate excision, the skin was closed and the haematoma was relied upon to restore the damage of excision. Discussing the method in detail, he concluded that the essential points were: 1) thorough radiographic examination, including investigation of sinus tracks; 2) culture to determine the types of organisms present and their sensitivity to available antibiotics; 3) parenteral antibiotic therapy, begun twenty-four hours before operation; 4) adequate surgery to eliminate fully the infected area and to leave only living tissue; 5) avoidance of oedema at the site of operation, but walking allowed as soon as possible; 6) when complete excision or skin cover was impossible, local instillation of the appropriate antibiotic; "physiological curettage" was complementary to this attack—streptokinase to liquefy old clot and streptodornase to digest fibrous tissue sloughs. Mr Hodgkinson quoted cases of bone infection in which these principles had been successfully applied.

ROYAL AUSTRALASIAN COLLEGE OF SURGEONS

MEETING OF NEW SOUTH WALES BRANCH

A meeting of the New South Wales Branch of the College was held in the Stawell Hall on June 24, 1953, with Mr Livingston Spencer in the Chair.

Amputations—*Mr McClemens Callow* (Sydney), in opening a discussion on amputations, said that the first question was at what level to amputate, and he had found that surgeons differed. In the upper limb it was generally conceded that the stump should be as long as possible, with emphasis on function rather than appearance. He thought, however, that in fingers conservatism was often overdone, and he had found that skin grafting over bone, where the digit had to stand up to heavy work, almost invariably failed. Amputations of the upper limb should never be performed solely to fit a prosthesis. In his experience, kineplastic surgery had not helped the worker much. In the lower limb he favoured retaining toes, if possible, to prevent callosities beneath the metatarsal heads. He thought that mid-tarsal amputation had a definite place in spite of the tendency to plantar flexion at the stump which might require arthrodesis of the ankle. A great advantage of this type of amputation, particularly in women, was that it allowed a normal-looking shoe. He wished to emphasise that the Syme operation had deservedly regained favour. A six-inch tibial stump was best in amputation through the shaft, though even if only one inch remained it was possible to fit a satisfactory walking appliance. A short stump required a special knee mechanism. Amputation through the knee joint gave successful results, and could often be made end-bearing though the prosthesis was more difficult to fit than after a below-knee amputation. If the knee joint was lost, a three-inch clearance must be given to allow for the knee mechanism. The time for fitting a prosthesis was determined by the sound healing of the wound and absence of oedema. He thought that most troubles in amputation stumps were simple ones: 1) an ill-fitting prosthesis with compression of the skin from too much movement of the bucket; 2) superficial infection, from inadequate hygiene; 3) adventitious bursae over the tubercle of the tibia, calling for excision if conservative treatment failed; 4) increased weight, a frequent cause of oedema and ulcerations; 5) breaking down of an adherent terminal scar, usually better treated by shortening the stump rather than by skin-grafting; 6) neuromata, calling for removal. He believed that every patient with an amputation suffered some degree of phantom pain, and that the most important factor in some patients was the psychogenic one.

Painful phantom limbs—*Mr Stuart Morson* (Sydney), speaking as a neurosurgeon, emphasised how few patients with amputations required neurosurgical treatment, an observation in keeping with Dr Callow's statement that, in a review of 1,000 amputees in New South Wales, only eight or ten complained of intractable pain.

Phantoms occurred in practically all amputees; some discomfort was felt in every phantom, in the form of tingling and writhing movements, tending to be fugitive and usually almost disappearing within two or three years, though sometimes persisting for twenty or thirty. Exacerbations of this "natural discomfort" occurred with fatigue, ill health, change of weather, instinctive supporting reactions, and, in some cases, with micturition.

From 5 to 30 per cent of patients had enough stump pain to warrant medical attention. Pains related to neuromata or scar tissue were usually intermittent and in the nature of tingling, but might be severe and lancinating or even cramping. Infections might produce pain and throbbing on movement. Interstitial neuritis from prolonged sepsis might give rise to pain, particularly if the part were warm or dependent. Boring, burning pain might be associated with a stump that was cold, sweaty, cyanotic and atrophic. This was to be distinguished from the causalgic pain in the congested stump secondary to constriction by the bucket of the prosthesis.

There remained about 1 per cent of patients in whom pain was intractable and severe, usually related to the phantom. It might be causalgic in character, lancinating or shooting, cramping or twisting, or complex and grotesque. These patients usually showed evidence of psychological disturbance, and addiction to morphia or alcohol was common. Jactitation or " epilepsy of the stump " was an indication of severity of the pain.

Any anxiety, particularly about compensation or pension, aggravated, and much could be done by reassurance and correction of sociological problems. Often local stump pain could be temporarily alleviated or cured by simple measures: repeated procaine infiltration, resection of tender neuromata, trimming of the stump, or removal of scar tissue or bursa in revision of the stump. Percussion of superficial neuromata, a method reintroduced by Dr Ritchie Russell, had not come up to expectations, possibly because of lack of supervision and of the avidity of some patients for their pensions. Of 100 patients so treated at Roehampton, only about one-quarter had reasonable relief; this agreed with Dr Russell's own findings. It was not yet known whether relief was conditioned by degeneration and fibrosis in the neuroma or by the tetanizing effect of barrages of impulses arriving at the substantia gelatinosa, a theory put forward recently by Murray Falconer. Spinal or epidural anaesthesia might give temporary relief, lasting up to three months. Another method of attacking the first-order pathway in the spinal canal was posterior rhizotomy, but this method had proved unreliable, and was contra-indicated because the loss of postural sense, as well as loss of superficial sensation in the stump, made an artificial limb uncontrollable.

Sympathectomy, preceded by diagnostic paravertebral block or therapeutic injection of sympathetic ganglion blocking agents such as hexamethonium bromide, had succeeded in some cases with stump hyperpathic causalgic manifestations, but had rarely helped phantom pain.

The second-order sensory pathway might be interrupted by such measures as chordotomy or spino-thalamic tractotomy.

Posterior chordotomy had been designed by Pool and by Browder to sever proprioceptive pathways and thus relieve the cramped, painful position of phantom digits, but in the cervical region no relief was obtained unless the incision was extended laterally to include the substantia gelatinosa and Lissauer's tract. Only nine cases were reported in the literature, and seemingly this procedure had relieved about one-quarter of the patients. On the other hand, contra-lateral antero-lateral chordotomy had been more successful and was the best operation so far designed for intractable pain.

Brachial plexus pain might be relieved by operation at cervical 1–2 level, but, as the pain pathways were deep and easily missed, it was essential for the operation to be carried out under local anaesthesia. This method had proved effective in about half the cases. Chordotomy for lower limb pain was carried out at the T.2–3 level under a general anaesthetic, and about two-thirds of the patients obtained good relief. Murray Falconer's report on twelve cases constituted the most recent review of the position.

Medullary spino-thalamic tractotomy, as recently described by Crawford and Knighton, was carried out at a level between the vagus and accessory roots, 3 or 4 millimetres below the obex or lowest portion of the fourth ventricle. It had successfully relieved severe shoulder pain from carcinomatous infiltration, but side effects, including ataxia and analgesia of the face in addition to analgesia of the whole of the opposite half of the body, would probably preclude it for amputation cases.

Mesencephalic tractotomy and mesencephalopathy effected by the stereo-encephalatome had been used for intractable facial pain but seemingly not for upper phantom limb pain.

There were several reports of temporary abolition of phantom pain from cortical excision and the disappearance of a phantom had been reported after thrombotic infarction of the sensory cortex contra-lateral to the ghost part. Two cases in which a painful phantom had become comfortable for hours to days after epileptiform convulsion starting in the opposite hemisphere were also known. Perhaps cortical excision would not have been attempted but that stimulation of the appropriate area of limb representation reproduced the patient's typical painful sensation, and this had led observers to suppose some inter-relationship between the thalamus and cortex in the conscious appreciation of pain. This method had proved unreliable, as recurrence was the rule; there was also the risk of epilepsy from cortical scarring; and it was very doubtful whether the complete sensory projection area of the limb could ever be excised without unjustifiable disability; centrifugal impulses passed, not only to the post-rolandic, but also to the pre-rolandic cortex, and excision of this would cause loss of postural sense. There was also the recently described sensory projection to the secondary somatic area in the upper lips of the Sylvian fissure, and this would escape resection. Yet another objection was that pain in all probability enters consciousness at a diencephalic level.

Leucotomy might help as a last resort in these conditions of intractable phantom pain but

it provided only a relative, rather than an absolute, barrier to pain. Unilateral leucotomy had the advantage that addiction might be cured without the associated personality changes of the bilateral operation. Whether the unilateral or bilateral operation was used, pain related to involvement of large nerve roots or trunks was seemingly much more difficult to alleviate.

Electro-convulsive therapy had been given a trial, and much relief by this means had been reported.

As a final therapeutic measure, mass hypnosis had been used in France, with some relief of one to two months' duration.

In conclusion, little could be said about the theory of causation of painful phantoms. It could not be denied that " pain " impulses originated in the cut ends of the peripheral nerves and that these centrifugally directed impulses were being reduced in number, disorganised as regards time-space pattern, and dissociated from other sensory modalities. Abnormal pain impulses might thus arise solely from the neuroma which constituted the irritable focus, and in these cases peripheral operations might cure. Pain impulses might, however, be perpetuated at other levels, either in the substantia gelatinosa as evidenced when the peripheral attack failed but chordotomy succeeded or in the thalamo-cortical circuit when even chordotomy was ineffective. The relative ineffectiveness of any one standard procedure was surely an indication of well known neurological facts; in the first place the widespread scattering of pain pathways to the extent of ipselateral perception as evidenced in hemispherectomised patients, and secondly the awareness of pain at a diencephalic level.

Discussion—Various speakers brought out 1) that, in amputation through the knee joint, the patella should be removed and its ligament sewn to the hamstrings, 2) that, in diabetic gangrene, conservative surgery was justifiable, with the prospect of higher operation later, and 3) that the type of injury and the consciousness of the patient when it was sustained were factors in phantom pains.

DENMARK

A STUDY OF THE EPIDEMIC OF ACUTE ANTERIOR POLIOMYELITIS IN DENMARK, 1952–53

Mr Alan Glass (Manchester) has submitted a report of his study of the epidemic of poliomyelitis in Denmark, 1952–53. He writes:

In May 1953 the Manchester Babies' and Children's Hospital Management Committee sent me to Denmark for the purpose of studying the epidemic of poliomyelitis which had recently occurred in that country. This report is an account of the way in which the administrative and clinical resources of Denmark were used to deal with the grave emergency that arose.

The epidemic began in the first half of June 1952 and was considered to be at an end at the beginning of February 1953. The total number of patients notified was 5,676, of whom 2,450 developed some degree of paralysis and 262 died. The brunt of the epidemic was felt in the Copenhagen area, where 3,022 cases were reported—1,336 with paralysis—in a total population of 1,200,000.

The first case was reported from a locality near an open canal, and the earlier cases tended to occur near canals of the same type, much as had happened in the New York epidemic of 1916. The spread in the outskirts of Copenhagen tended, at first, to follow main traffic routes, but this tendency was later obscured, presumably by contact infection.

ADMINISTRATION

On notification, patients were admitted first to epidemic departments or to fever hospitals. In Copenhagen this meant admission to the Blegdamshospital, which is normally used partly as a fever hospital and partly as a general medical hospital. It has a total of 500 beds, of which 380 are normally used for infectious cases. During the epidemic the whole hospital was used for the treatment of patients with poliomyelitis from the Copenhagen area, and it became the centre for the treatment of bulbar and respiratory cases for the whole of Denmark, so far as such centralisation was possible.

The original staff of Blegdamshospital numbered 280, and the hospital had one physiotherapist. During the epidemic the number of nurses employed was 640. The extra nurses were either borrowed from other hospitals or drawn from a bureau which employs private nurses.

A tremendous increase in the physiotherapy staff was essential, and a total of sixty physiotherapists were employed simultaneously to carry out treatment under the supervision of an orthopaedic surgeon, a specialist in physical medicine, and his two assistants. Most of the

physiotherapists were supplied by the National Foundation Against Poliomyelitis, which obtained recruits from many other countries, including Great Britain. Apart from those mentioned above, the hospital engaged ten part-time physiotherapists who were employed in the treatment of the respiratory disorders. No great increase in the domestic staff of the hospital was found to be necessary, apart from the employment of twenty-five men who were responsible for handling the heavy cylinders of oxygen.

It rapidly became evident, because of the ceaseless flow of patients, that special arrangements would have to be made for their disposal and for their further treatment during the convalescent phase. For this latter purpose, other municipal hospital beds were made available, and patients were transferred to them a few days after the onset of the disease, unless they were suffering from a bulbar or a respiratory paralysis.

The Society and Home for Cripples, which controls all the orthopaedic hospitals and clinics in Denmark, undertook the responsibility of treating all paralytic patients requiring in-patient care, and for this purpose special arrangements were made to give the orthopaedic teams access to the beds at Blegdamshospital in Copenhagen, Marselisborg Hospital (the epidemic hospital in Aarhus), and also to beds in municipal hospitals not normally under their control. Orthopaedic treatment was therefore instituted at the earliest possible moment after paralysis had occurred. In Copenhagen alone, this meant that 530 extra beds came under orthopaedic supervision, apart from those at the major epidemic hospital. The expense of these arrangements was partly met by a grant of £120,000 which was made by the Ministry of Social Affairs.

FIG. 1
Map of Denmark showing the centres and towns referred to.

The problem of prolonged in-patient orthopaedic care was largely solved in Zealand by the timely purchase by the Society and Home for Cripples of a large seaside hotel at Hornbaek. This was converted into an orthopaedic hospital accommodating 200 patients. Ten days after the purchase of the hotel, the first patients were admitted, and were receiving treatment. In Jutland arrangements were made with the Danish Red Cross Hospital at Hald, whereby about 200 of its 425 beds became available for similar use.

Many patients on recovering from the acute attack have required continued supervision and treatment as out-patients. This is partly being carried out at the orthopaedic hospitals in Copenhagen and at Aahrus, and partly by a considerable extension of the out-patient facilities provided by the National Foundation Against Poliomyelitis at their Institute in Copenhagen, where 1,000 new out-patients have been seen and treated.

This private foundation has acted throughout in the closest co-operation with the Society and Home for Cripples, the two societies together providing new out-patient clinics at Odense, Kolding, Aarlburg and Randers. The National Foundation Against Poliomyelitis was able to supply respirators from its stock, and to arrange the supply of further respirators from the other Scandinavian countries, America and Holland. The foundation was also responsible for designing a new apparatus for hot packing, and was active in the provision of specially trained physiotherapists. It issued to all Danish doctors a monograph which dealt with the prevention and treatment of the disease, and it conducted propaganda by means of the press and radio.

CLINICAL MANAGEMENT

Respiratory and bulbar paralysis—Acute respiratory failure was the most pressing problem in the acute stage of the disease. Such failure occurred in 345 patients, the greatest number requiring artificial respiration at Blegdamshospital in any one day being seventy. At first, either cuirass-respirators or tank-respirators were used, but these were soon abandoned because of the number of patients, because insufficient ventilation was obtained and because they are of little

use if swallowing is impaired. Direct positive pressure manual intratracheal respiration was found to be much superior. The method has been well described by Lassen (Lancet, 1953, **i**, 37). It consists of the passing of a cuffed rubber tube through a tracheotomy at the level of the second ring, followed by the manual compression of an attached bag eighteen to twenty times per minute, using a short inspiratory phase and a long expiratory phase (Fig. 2). A soda lime absorber is attached. Pure oxygen was used for the first two hours, followed by a 50 per cent oxygen-nitrogen mixture. The manual compression was carried out chiefly by medical and dental students working in relays, about 200 students being employed. Patients were gradually weaned on to intermittently assisted respiration, and most ultimately dispensed with the tube, using a respirator for shorter and shorter periods, until they became self-supporting. In some cases, several months elapsed before this state of affairs was reached, and there is a most unfortunate residue of thirty-one patients who, so far as it is possible to tell, may require the permanent use of artificial aids to respiration. Nevertheless it has been observed both by clinical and radiological study that diaphragmatic movement and spontaneous respiration may commence many months after the acute attack.

The complications of respiratory paralysis treated by the above method have been few, and have consisted in the complications of the disease itself, pulmonary atelectasis, pneumonia, shock, and one complication of the treatment—namely, tracheal stenosis. Patients who required this method of treatment had regular and vigorous physiotherapy. Frequent sucking out of the trachea and bronchi was needed to maintain a clear airway. This reduced the danger of atelectasis, which was further guarded against by keeping the oxygen-nitrogen mixture adequately humidified. Penicillin, streptomycin and aureomycin were given to prevent pneumonia.

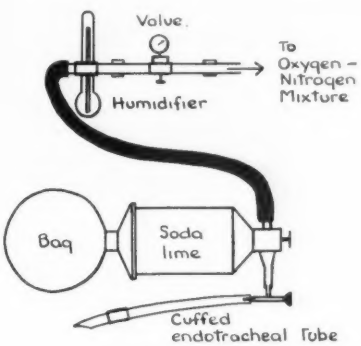

FIG. 2

Diagram to illustrate the positive-pressure manual intratracheal method used to ventilate the lungs in cases of bulbar palsy. (Modified from Lassen.)

Patients with respiratory paralysis were found peculiarly prone to a condition resembling surgical shock, in which state the patients became cold and clammy, with collapsed veins, lowered blood pressure, and raised haemoglobin levels in the blood. The "shock" often became evident when respiration was re-established. The precise etiology of this condition was difficult to determine. Carbon dioxide retention was suspected, as was palsy of the vaso-motor centre due to the disease. Other factors may have been the pressure of toxic, perhaps poliomyelitic, myocarditis or of peripheral circulatory failure. The shock was treated along accepted lines, some patients requiring intravenous infusions.

In the early days, tracheal stenosis constituted a major problem. It is partly due to prolonged use of a long rubber tube, and partly to the very high tracheotomy opening. It was later found that the tube could be replaced by a short silver tracheotomy tube much earlier than had previously been done, and this should help in minimising the occurrence of this distressing complication.

A total of 275 patients were treated by tracheotomy and bag ventilation. The mortality rate in this group was 41 per cent, which represented an enormous improvement. Methods previously used had a mortality rate of 80 per cent (Lassen, Lancet, 1953, **i**, 37). It is important to state that not a single case of anterior poliomyelitis occurred among the doctors, nurses, physiotherapists or students who were responsible for carrying out the treatment.

ORTHOPAEDIC ASPECTS

Physiotherapy was begun immediately after the febrile stage had passed. Patients were allowed to lie in any position of comfort they cared to adopt for the first one or two days until the pain had begun to decrease. The position adopted indicated to the physiotherapists the areas in which there was greatest muscle "spasm." In this stage hot, moist packs were extensively used in Copenhagen, but not in Aarhus. In all centres, when the pain and tenderness had decreased sufficiently, the patient was gradually stretched into a more physiological position, and laid supine on a hard bed board of standard type, which had a vertical end piece to prevent a drop foot, a suitable gap being left to accommodate the feet during prone lying. During this early stage pillows were used to prevent overstretching of paralysed muscles.

The question of further splintage revealed a cleavage of opinion amongst the orthopaedic authorities in Denmark. The Copenhagen school avoided splintage as far as possible, except when contractures had actually occurred, as in the tendo calcaneus or the ilio-tibial band. The most important method in prevention of deformity was thought to be regular and frequent stretching of tight tissues, preceded by the application of hot packs or paraffin baths.

The Aarhus school regarded splintage as a most important factor in the prevention of deformity, and combined it with hot packs and with stretching. Splints were usually made from

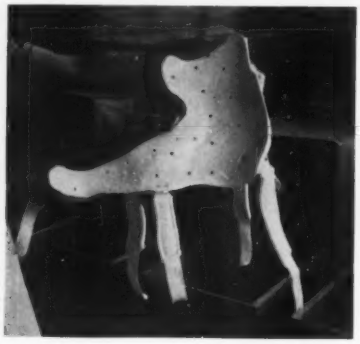

FIG. 3

FIG. 4

The " bending-bed," empty and in use.

" Celastic," a material which has the advantage of being durable, washable and easily moulded. They were designed to relax paralysed muscles and to prevent contractures. Special mention must be made of the " bending bed " (Figs. 3 and 4) which was used in an attempt to prevent or minimise paralytic scoliosis in cases which showed asymmetrical palsies of the trunk musculature, and also of an abduction arm splint (Fig. 5), designed at Hald, which allowed maximal function of the arm, while keeping the paralysed deltoid relaxed. Pool therapy was found very useful in both centres, and was preferred to slinging except for trunk exercises. In the Aarhus school the patients entered the pool with aluminium back splints attached to their legs to aid in the maintenance of balance.

FIG. 5

The Hald abduction splint.

Stress was laid in both centres upon the importance of avoiding fatigue, and upon correct postural training both while sitting and standing. The question of when to bear weight was regarded as an entirely individual problem, and if a paralytic scoliosis was feared, all were agreed that long periods of bed rest are essential.

It is early to say what the final attitude towards reconstructive surgery will be, but the tendency is for early tendon-transfer at between six months and twelve months after the onset of the disease, on the grounds that if little or no function is seen in a paralysed muscle at this time then no useful function will ever be regained, and the best chance of preventing deformity and of improving the function of the member lies in re-establishing muscle balance at this early stage.

SOCIAL MANAGEMENT AND REHABILITATION

In March 1953 a special law was passed in Denmark ensuring that the standard of living of a family whose earning member is under treatment for poliomyelitis should be kept up to the standard previously existing within reasonable limits calculated on the cost of living index. This

brought the poliomyelitis patient into line with sufferers from tuberculosis. It applies for periods up to four years from the acute attack. The patient who becomes totally disabled is helped financially by a fixed annual grant from the Invalid Insurance Board.

Private firms are helpful in allowing patients to undertake part-time work on full rates of pay. Patients requiring a change of occupation undergo special training in workshops which are attached to and managed by the Home and Society for Cripples, or are sent for apprenticeship to private firms by the Invalid Insurance Board which makes up the patients' wages to a reasonable level.

Three residential Crippled Children's Schools are available, accommodating up to 150 patients, and schooling and occupational therapy are provided at the long stay hospitals at Hornbaek and Hald. There exists, at the moment, only one day-school for crippled children. It is situated in Copenhagen, and is attached to the residential school managed by the Home and Society for Cripples. Children who are not able to attend school at all are being taught in their own homes. In a child of school-leaving age the handicap is assessed and an attempt is made to give him either a vocational training or further schooling in order to train him for the job requiring a higher education.

Co-operation between the State, the orthopaedic authorities and private employers has therefore ensured adequate economic support of adults and adequate education and training of children who are handicapped as the result of this epidemic.

A central card index file of all the cases occurring in Denmark is being at this moment established at the orthopaedic hospitals, so that follow-up of all the patients is ensured.

COMMENT

The epidemic described above was regarded as a national emergency. Such a catastrophe might occur in the United Kingdom at any time in the future. We must benefit from this Danish experience and make adequate preparation. It is the responsibility of the Ministry of Health and the various professional bodies concerned, including the British Orthopaedic Association, to ensure that trained teams of doctors, nurses and physiotherapists are available to treat, under emergency conditions, an epidemic which may put about one in every 400 persons at risk. Arrangements will have to be made whereby rapid evacuation of hospital beds, and, if necessary, the opening and equipping of new hospitals, can be carried out within a very short time.

There is no doubt that the prevention of deformity and the re-eduction and training of paralysed muscles is best commenced in the acute and early convalescent phases of the disease. The person who, by virtue of his training, experience and interest is most fitted to plan and supervise this highly important aspect in the management of the disease is the orthopaedic surgeon. The place of the orthopaedic surgeon is therefore in the fever hospital during the acute stage of the disease, where he should work in the closest co-operation with his colleagues. To argue any other way is to show ignorance of the problems involved. The whole experience of the Danish epidemic emphasises this point.

SUMMARY

1. The poliomyelitis epidemic in Denmark from June 1952 to February 1953 produced 5,676 cases, of which 2,450 were paralytic. Of the total cases, 3,022 occurred in the Copenhagen area, and of these, 1,336 were paralytic.

2. Special administrative arrangements were made between the Home and Society for Cripples in Denmark, the National Foundation Against Poliomyelitis and the municipal and State authorities for rapid expansion of the orthopaedic and physiotherapy services.

3. Respiratory cases were treated by positive-pressure manual intratracheal respiration, with a considerable decrease in mortality.

4. Patients came under orthopaedic supervision during the acute stage of the disease.

5. The social laws of Denmark adequately covered both the economic support of the adult patients and the education and training of the child.

My thanks are due to the Manchester Babies' and Children's Hospital Management Committee which supplied a grant of money for the purpose of studying the epidemic, and also to my Danish colleagues who freely supplied any information I requested. In particular I would thank Dr Johannes Mortens of Copenhagen, whose help in preparing this account has been invaluable.

FRANCE

FRENCH SOCIETY OF ORTHOPAEDIC AND TRAUMATIC SURGERY

A meeting of the French Society of Orthopaedic and Traumatic Surgery was held in Paris on October 7, 8 and 9, 1953, under the presidency of Professor P. Ingelrans of Lille. The main subjects for discussion were: 1) scoliosis, opened by Drs P. Stagnara (Lyon) and P. Queneau (Paris); and 2) treatment of ankylosis and stiffness of the knee, opened by Drs J. O. Ramadier (Paris) and M. Lacherez (Lille).

In addition to a large gathering of French orthopaedic surgeons, there were present at the meeting a number of foreign surgeons, including Dr J. Delchef, Dr R. Soeur and Dr P. Dupuis from Belgium; Mr J. G. Bonnin from England; Dr F. Pauwels from Germany; Dr S. von Rosen from Sweden; Dr E. Trojan from Austria; Dr C. Marino-Zuco, Dr C. Camurati and Dr E. De Marchi from Italy; Dr A. Manzoni from Yugoslavia; and Dr H. W. Wouters from Holland.

At the business meeting new members were elected, and Dr P. P. Petit was nominated a member of the executive.

Future meetings—The main subject for discussion at the 1954 Congress will be the treatment of congenital dislocation of the hip in early infancy, opened by Dr R. Meary (Paris) and Dr R. Gourdon (Vannes). In 1955 the chief topic will be the use of inert prostheses in joint surgery, opened by Dr M. Guilleminet (Lyon) and Dr Robert Judet (Paris).

INTERNATIONAL SOCIETIES

INTERNATIONAL CONGRESS OF HYDRO-CLIMATOLOGY AND THALASSO-THERAPY

The International Congress of Hydro-climatology and Thalasso-therapy will take place at centres on the Adriatic coast of Yugoslavia from May 8–16, 1954. The president of the congress will be Professor B. Niketic, and the general secretary is Professor C. Plavsic. Those attending the congress have been invited to submit papers and to take part in discussion. Papers will be translated in public at the Congress and summaries will be printed in four languages. The centres to be visited will include Opatija, Rab, Split and Dubrovnik. The scientific programmes will be arranged in three sections, and the provisional programmes are as follows. **Section 1—Thalasso-therapy** (President: Professor E. Sorrel of Paris; Secretary: Dr M. Horvat of Rovinj). The subjects for discussion are: 1) Bioclimatic factors in thalaso-therapy; and 2) The significance of thalasso-therapy in the modern treatment of skeletal tuberculosis. **Section 2—Medical hydro-climatology** (President: Professor M. Messina of Rome; Secretary: Dr R. Leskovar of Rogaska Slatina). The subjects for discussion are: 1) The neuro-vegetative system and hydro-climatic treatment; 2) The significance of hydro-climatic treatment in rheumatic diseases; 3) The significance of hydro-climatic treatment in diseases of the respiratory tract; and 4) Hydro-climatic treatment in hypertensive diseases. **Section 3—Social, economic, technical and judicial questions in connection with hydro-climatology** (President: A. Schirmer of Baden; Secretary: Professor S. Miholic of Zagreb). The subjects for discussion are: 1) The question of analytical methods in the examination of mineral waters; 2) Hydro-climatic treatment from the viewpoint of social medicine; 3) Noise control in spas and climatic places; and 4) The question of propaganda for hydro-climatic places.

Book Reviews

FUNCTIONAL AND SURGICAL ANATOMY OF THE HAND. By Emanuel B. KAPLAN, M.D., F.A.C.S., Assistant Professor of Anatomy, College of Physicians and Surgeons, Columbia University. 10×7 in. Pp. xvi+288, with 132 figures. Index. 1953. Philadelphia, London, Montreal: J. B. Lippincott Company. Price 80s.

This book has been published at an opportune time in view of the widespread interest that is being taken in the treatment of hand disabilities. It will prove a valuable aid, and can be recommended to all surgeons working in this fascinating field.

Dr Kaplan has made many personal studies of the anatomy of the hand, and his findings are well presented, those dealing with the variations from normal being particularly useful. The work is written with movement and function constantly in mind, and abounds in practical considerations. There are three sections dealing in turn with the hand as an organ, structure and function of the hand, and surgical anatomy. The main part concerns structure and function, and is written in great detail. The chapters on joint movements and muscle and tendon action are most instructive.

In general, the text is well illustrated from original dissections, many of which depict anatomy from an unusual viewpoint. They are beautifully and clearly drawn, and the reader would enjoy seeing even more of them. Here, indeed, is the only ground for serious criticism. It is disappointing, for instance, to find no adequate demonstration of the collateral ligaments of the finger joints, an understanding of which is so important in determining the correct position for joint immobilisation. The section on the vascular and nervous systems could be improved by the more liberal use of illustrations. The same criticism applies to the short chapter on surface anatomy, a subject which can be more readily appreciated from diagrams than from text.

The book is excellently printed, and is in keeping with the high standard of the publications of Messrs J. B. Lippincott Company.—R. Guy PULVERTAFT.

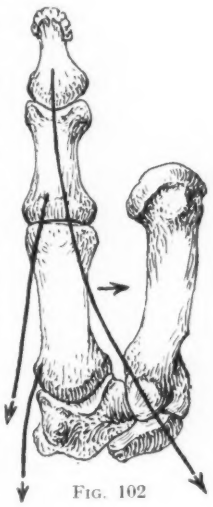

FIG. 102

FIG. 102

The action of the extensor pollicis longus which produces extension of the distal phalanx, of the middle phalanx and of the first metacarpal with strong adduction of the first metacarpal toward the second metacarpal. The extensor pollicis brevis and the abductor pollicis longus act simultaneously as stabilizers.

PHYSICAL MEDICINE AND REHABILITATION. Edited by Basil KIERNANDER, M.B., M.R.C.P., D.M.R.E., D.Phys.Med., Director, Physical Medicine Department, Hospital for Sick Children, Great Ormond Street, and Royal National Ear, Nose and Throat Hospital, London; with an introduction by The Rt. Hon. Lord Horder, G.C.V.O., M.D., F.R.C.P., President, British Association of Physical Medicine; and twenty-six contributors. 9×6½ in. Pp. xiv+610, with numerous figures. Index. 1953. Oxford: Blackwell Scientific Publications. Price 63s.

The editor of a text-book on physical medicine begins with the difficult task of deciding how much he must include and how much he may leave out: for physical medicine is too large a subject to be treated fully in a book of reasonable size. The editor of the present text-book has wisely limited his field, though he has not resisted the temptation to include—presumably for

completeness—chapters that are too short to be of value. The book starts with a characteristic and appropriate introduction by Lord Horder on " The Meaning and Scope of Physical Medicine." Then follow twenty-four chapters to which twenty-eight authors contribute. Of these contributions, eight come from Canada and the United States. There are two outstanding chapters: " The Functional Anatomy of the Locomotor System " by Darcus, and " Physical Methods used in the Diagnosis and Treatment of Neuromuscular Disorders " by Ruth Bowden. Both are long—ninety and sixty-six pages respectively; both contain a great deal of information; both are admirably arranged. There are several chapters which will be of value to those working in fields other than physical medicine, as, for example, Howard Rusk's " The Rehabilitation of the Hemiplegic " and O'Malley's " Organisation of Medical Rehabilitation and Industrial Resettlement." There is indeed much useful information to be found in this book.

There are, however, faults of three kinds which mar several chapters and are likely to distract and irritate the reader. First, even allowing for the fact that this book was printed abroad, there are far too many printer's errors; thus on page 477 the femoral head is said to be displaced on to the ileum (in congenital dislocation of the hip); the exercises for ataxia are ascribed to Frenkel (page 275), to Fruenkel (page 606), and to Fränkel (in the index). Secondly, too little time has been spent on correcting the English, so that ungrammatical sentences such as the following on page 606 have been allowed to remain: " When the average patient, who *is* fairly insensitive to heat in the prostate *received* the correct dosage, he *will experience* a pleasant glow of warmth " (reviewer's italics). Thirdly, no attempt has been made to use a uniform system of references, and some chapters in which a list would have been welcome contain no references at all. A really good English text-book of physical medicine is badly needed. All the more pity, therefore, that this book with its eminent contributors and with the good material it contains, should be spoilt by so many unnecessary blemishes.—Hugh BURT.

RÉADAPTATION DES ENFANTS ATTEINTS D'INFIRMITÉ MOTRICE. Compiled and edited by Ch. MARTIN, with forty-three contributors. 10 × 6½ in. Pp. 435, with some figures. 1952. Paris: Centre International de L'Enfance. London: Lange, Maxwell & Springer Ltd. Price £3.

Every British orthopaedic surgeon should have a look at this book if only to see how low British orthopaedic surgery stands in the opinion of such international bodies as the Economic and Social Council of the United Nations, the World Health Organisation, " Le Fonds Internationale de Secours a l'enfance," the International Bureau of Labour, and the International Union for the Protection of Childhood. For these are the bodies that were responsible—so the introduction tells us—for inspiring and organising the course of lectures that this book records. And under the auspices of U.N.E.S.C.O. a programme was arranged in France and Great Britain presented by forty-three specialists, among whom the organisers chose to include only one British orthopaedic surgeon practising largely with children, namely Mr J. A. Cholmeley, who spoke on " The use of splints in the treatment of Polio." From Great Britain, Dr W. R. Russell deals with " Ideas on the aetiology and treatment of Polio " (at least that is his title but in fact the lecture is on etiology and the fatigue factor); Professor J. Trueta with " Inequality of limbs and their treatment "; Dr C. J. S. O'Malley with " Rehabilitation " (in the adult); Dr L. Guttmann with " Paraplegias " (in the adult). The British orthopaedic surgeon does not, however, stand quite as low as his paediatric colleague. I would not care to say in this review what British paediatric physicians will think of their complete exclusion from the forty-three lecturers chosen by the International Centre of Childhood to speak on a subject so essentially paediatric. If the Introduction is to be believed, physicians, paediatric or otherwise, were not even included in the " audience," which is described as " thirty doctors specialising in the care of muscularly weak children—neurologists, orthopaedists and surgeons."

But what of the contents of the book—the lectures themselves ? Well, I don't know whether " the curate's egg " has an international flavour, as this book is supposed to have, but, for readers to whom the expression is new, it was " good in parts." I liked Trueta's lecture; it is purposeful and has a " smack " about it which evokes a picture of the lecturer; I liked Petit's arthrograms and his lecture on congenital club foot (he is better on " talipes equinovarus " than on " talus equinus " or " convex foot " as he calls it); I liked Merle d'Aubigné's two lectures on " Peripheral nerve lesions " and " Sequelae of burns." They were neat, tidy, readable, and très Merle d'Aubigné. Probably the others were above my head.—Bryan MCFARLAND.

PATHOLOGY OF TUMOURS. By R. A. Willis, D.Sc., M.D., F.R.C.P., Professor of Pathology, University of Leeds. Second edition. 10×7 in. Pp. xiv+997, with 500 figures and 54 pages of index. 1953. London: Butterworth & Co. (Publishers), Ltd. Price 84s.

In the five years since its first edition this work has become increasingly popular, and has largely replaced the classical tumour encyclopaedia of Ewing in the hands of British readers. The great advantage of Willis's book is that it is interesting and critical. The second edition

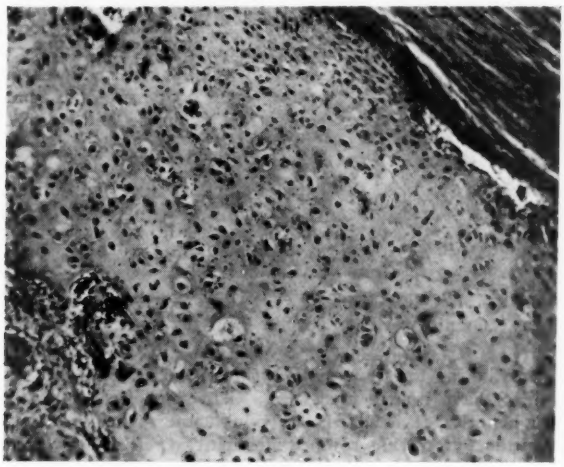

Fig. 328

Chondrosarcoma of upper half of humerus in a man of 41 years. At first diagnosed as a benign chondroma, the tumour recurred and metastasized to the lungs. (×60.)

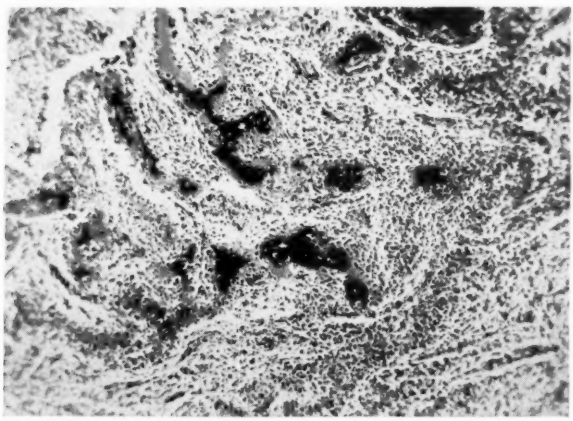

Fig. 333

From a lymph-nodal metastasis of osteosarcoma of humerus in a dog. (×40.)

shows very little alteration from the first, and in general Dr Dorothy Russell's review (Journal of Bone and Joint Surgery, **30–B, 576**) applies as much to it as to the first.

The special interests of the orthopaedic surgeon are well dealt with in this book, and attention may properly be drawn to them in a review of the second edition. Willis's views on bone tumours are well known to most of us, largely because of his refusal to accept indefensible concepts such

as those of the uni-centric origin of tumours and for his scientific analysis of the general principles of tumour pathology; and, though not all orthopaedic surgeons will agree, his refusal to accept " Ewing's Tumour " as a true bill is receiving wider and wider acceptance among us. Adamantinoma of the tibia must now go the way of other outworn ideas, and one is delighted to see him use the term " osteosarcoma " instead of the almost meaningless " osteogenic sarcoma " (but are the sarcomas of Paget's disease ever " osteogenic " ?). One is a little disappointed however that Willis still accepts the existence of " solitary " plasmacytoma, and few of us will agree that there is a " great increase " in the serum alkaline phosphatase in patients with sarcoma of bone.

When he deals incidentally with other aspects of pathology Willis will have fewer allies amongst us. He will get little agreement with his views of the nature of the osteoclast and of its ready convertibility into an osteoblast, nor will such statements as " bone is reconvertible into connective tissue " get very much approval, but a text-book on tumours which states that " far too great a reliance has been placed on radiographic appearances in the diagnosis of tumours of bone " must command respect among anyone who has had to handle the practical problems concerned with these diseases.

This is a fine book, and a real aid in the diagnosis of difficult tumours. It has all the advantages of the one-man text-book, and I thoroughly enjoyed reading the new edition, although new features are few.—D. Ll. Griffiths.

LA " SINDROME DA SCHIACCIAMENTO." By C. A. Montagnani. $9\frac{1}{2} \times 7$ in. Pp. 80, with 24 figures. 1953. Pisa: " Omnia Medica." Omnia Therapeutica, Supplemento IV. Price L.800.

This is a good contribution to the literature of post-traumatic anuria; the continental works dealing with this subject have been less extensive than those from the Anglo-Saxon countries. The work begins by an historical review of the early publications, particularly those by von Colmer, head of the German medical group who reached Messina two weeks after the earthquakes of 1909, and of D'Antona and of Salomoni, who treated large numbers of those victims from the early stages. Neither of these publications seems to contain any reference to delayed kidney failure after persistent crushing under debris; it has been commonly believed that they were the first publications to deal with this subject. The main features of the syndrome are well described and due attention is paid by the author to the more relevant theories on the cause and nature of the disorder. He gives special attention to the hypothesis that attributes the renal lesions to the elimination of muscle or blood pigments by the kidney, and he also comments on the evidence supporting the ischaemic nature of the kidney failure. In an attempt to throw light on the, as yet, not well understood problem of traumatic anuria, a series of well planned experiments were performed in dogs, causing muscle ischaemia for several hours by the use of a tourniquet. Substantial increase in myoglobin was detected but no case of kidney failure was observed among the dogs. In all of them a marked contrast was noted between the pale cortex and dark medulla, and ischaemia of cortical glomeruli was observed. Some hyperaemia of the juxta-medullary glomeruli was also apparent and the vessels of the medulla were found to be extremely hyperaemic. The author concludes that in the dog the presence of blood or muscle pigments in the kidney cannot have a direct pathological significance. He concludes that the kidney has a peculiar way of reacting to insults of the most diverse nature. His findings are confirmative of many others in different animal species and even in man. A good bibliography ends this well balanced study of a functional disorder that has a great surgical interest.—J. Trueta.

RARE MANIFESTATIONS OF METABOLIC BONE DISEASE. By I. Snapper, M.D., Ph.D., Physician and Director of Medical Education, Mt. Sinai Hospital, and Clinical Professor of Medicine, Columbia University College of Physicians and Surgeons, New York City. $8\frac{1}{2} \times 5\frac{1}{2}$ in. Pp. v+96, with 18 figures and 11 tables. 1952. Springfield, Illinois: Charles C. Thomas, Publisher; Oxford: Blackwell Scientific Publications. Price 21s. 6d.

In this, the Annual Beaumont lecture of 1950, skeletal affections in metabolic diseases are discussed with emphasis on some uncommon syndromes in which the bone changes are overshadowed by the metabolic. Instances are given in cases of parathyroid adenoma, namely: postnephrectomy uraemia secondary to nephrocalcinosis; death from uraemia secondary to necphrocalcinosis, in spite of successful operation on the adenoma fifteen years before; and simulation of diabetes

insipidus. The author describes cases of myelomatosis with symptoms of dysphagia, avitaminosis, arthritis and amyloidosis, and also describes difficulties of diagnosis in Paget's disease and postmenopausal osteoporosis. He considers that von Recklinghausen's disease of bone should never be diagnosed unless the blood contains an excess of calcium and alkaline phosphatase, and a deficit of phosphate, and unless the calcium and phosphate are increased in the urine, but that these changes do not necessarily imply this disease.—H. Jackson BURROWS.

TRAITEMENT DE LA PSEUDARTHROSE CONGENITALE DE JAMBE D'APRÈS UNE SÉRIE DE SEPT CAS. By Régis RICARD. 9½×6 in. Pp. 77, with 16 figures. 1953. Lyon: Bosc Freres. Price Frs. 250.

This little publication is described as a thesis. I would have thought there was in it hardly enough original or progressive work to justify this designation. It is in fact a dissertation, and not a very critical dissertation on its subject. If it had to be boiled down into a sentence, " The results obtained by Professor Guilleminet in treating pseudarthrosis of the tibia with Boyd's double onlay grafts " would be appropriate. The work is interesting in that it does show how good the " double onlay " can be, in spite of a prodigious proportion of metal. And, I must say, I was most impressed to see that, even when assaulted by seven screw holes and two encircling rings, the recipient tibia rejoined and remained in continuity. A point which is not stressed, but which emerges from the degree of success, is that it is wise to delay operation on a tibia affected by congenital pseudarthrosis. In the meantime it is of course necessary to keep the leg in a good line, to protect it from side stress by some means, and to permit the patient to walk. The review of previous attempts to explain congenital pseudarthrosis is neat and readable. Anyone interested in deformities of the lower leg, and in congenital pseudarthrosis in particular, would find this thesis well worth reading.—Bryan MCFARLAND.

THE QUIET ART, A Doctor's Anthology. Compiled by Dr Robert COOPE. 7×5 in. Pp. 284. Index. 1952. Edinburgh: E. & S. Livingstone Ltd. Price 12s. 6d.

This is an anthology of doctor and patient in literature, under the title *The Quiet Art*, a name given by Virgil to a physician's calling, comprising knowledge of medicines and the practice of healing. There is a profuse selection of extracts extending from the age of Greek medicine, beginning with the Hippocratic oath that " most memorable of human documents," down to the present time. Recurring reference is made to those personal qualities which, technical skill and ability apart, are found in the good doctor. Many quotations have been chosen because their ethical teaching is such as should guide those responsible for the care of stricken individuals; of such are the well chosen scriptural and devotional passages. The collection is compact of much wisdom born of experience in the observing of all sorts and conditions of men in their bodily weakness. Many members of the profession write in reflective mood about the frailties, aspirations and frustrations of human beings, most of them with compassionate feeling expressed with considerable literary grace.

The study of man in his reaction towards physical calamity presents the same problem everywhere. Hence the universality of the practice of medicine of which Osler reminds us:—" The profession in truth is a sort of guild or brotherhood, any member of which can take up his calling in any part of the world and find brethren whose language and methods and whose aims are identical with his own." Again, speaking on idealism at the American and Canadian farewell dinner to him on his departure for Oxford in 1905, Osler proceeds:—" I have had three personal ideals. One, to do the day's work well and not to bother about to-morrow. The second ideal has been to act the Golden Rule, as far as in me lay, toward my professional brethren and towards the patients committed to my care. And the third has been to cultivate such a measure of equanimity as would enable me to bear success with humility, the affection of my friends without pride, and to be ready when the day of sorrow and grief came to meet it with courage befitting a man."

There is a lovely poem on an apple tree by Anna Bunston de Bary, in Wiltshire dialect. Possibly it owes something to the influence of T. E. Brown and is reminiscent of the Dorset of William Barnes. Several selections give generous praise to practitioners of medicine but there is, too, some just criticism. Grey Turner relates how " many years ago, a woman in the seventies was highly indignant with her own medical man because he had told her that she was too old for

an operation. Her words of reproach, to the effect that 'old people had as much right to be relieved as young ones' have always been a guiding principle with me, and I have often proved their justification." Again Dr Herrick tells how he was greeted by a patient saying "I hope you will be different from the many physicians whom I have consulted. I hope you will examine the X-ray films less and me more." But the balance is restored, with good humour, by the behaviour of Lister of whom H. G. Cameron writes:—"Once a small urchin in the wards, as his eyes followed Lister's movements, confided to a bystander, 'It's us wee yins he likes best, and next it's the auld women.'" A more intimate description of Lister is given by his patient W. E. Henley, the distinguished writer and poet:—

His faultless patience, his unyielding will,
Beautiful gentleness and splendid skill.

. . . . . .

And seems in all his patients to compel
Such love and faith as failure cannot quell.

There can scarcely be a more exalting appreciation of medicine as a vocation than that by Robert Louis Stevenson when, writing of the ideal physician, he says:—"He is the flower (such as it is) of our civilisation; and when that stage of man is done with, and only to be marvelled at in history, he will be thought to have shared as little as any in the defects of the period, and most notably exhibited the virtues of the race." No patient was better qualified than Stevenson to ponder upon success and failure in medicine, for he had sought the aid of many physicians in his vain struggle against tuberculosis, at last dying in exile in Samoa where he had gone in pathetic quest of a cure. There he wrote his last familiar lines:—

Home is the sailor, home from sea
And the hunter home from the hill.

The author has searched diligently in literature for references to medicine, and they will be read with considerable gain and delight by those engaged in its practice. The reader's interest is aroused the moment the book is in his hands and its perusal cannot fail to increase that interest. Being an anthology of literature it differs from a text-book in that its contents have a permanency and are not fugitive or subject to revision. The book is well produced, is easily handled and the text is very clear.—A. Rocyn Jones.

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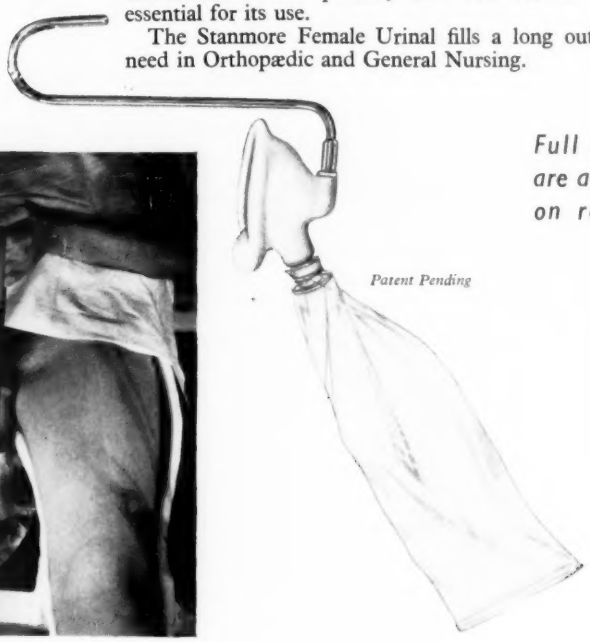

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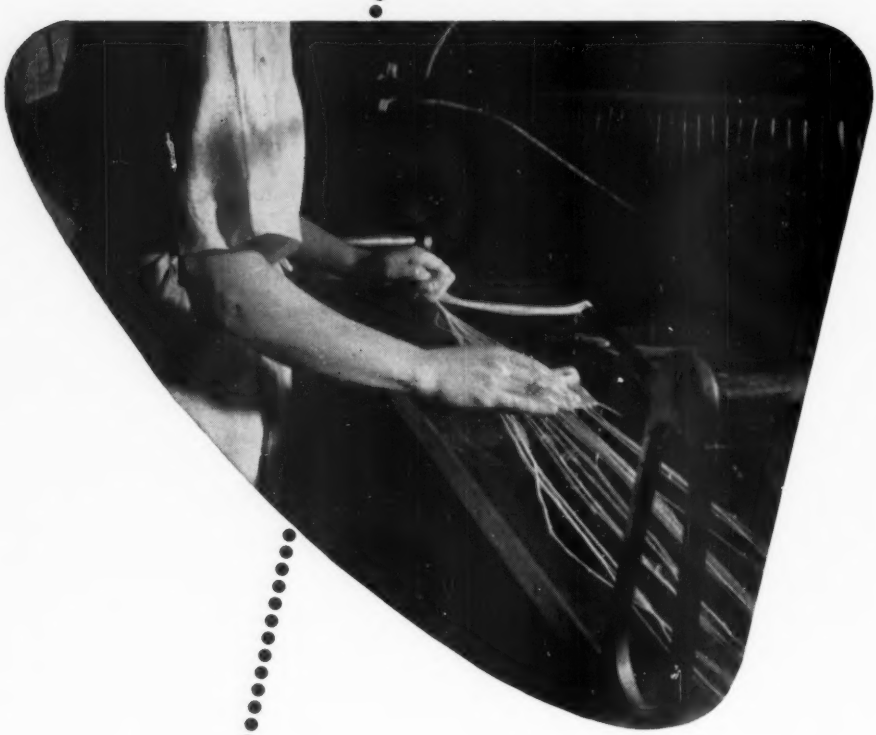

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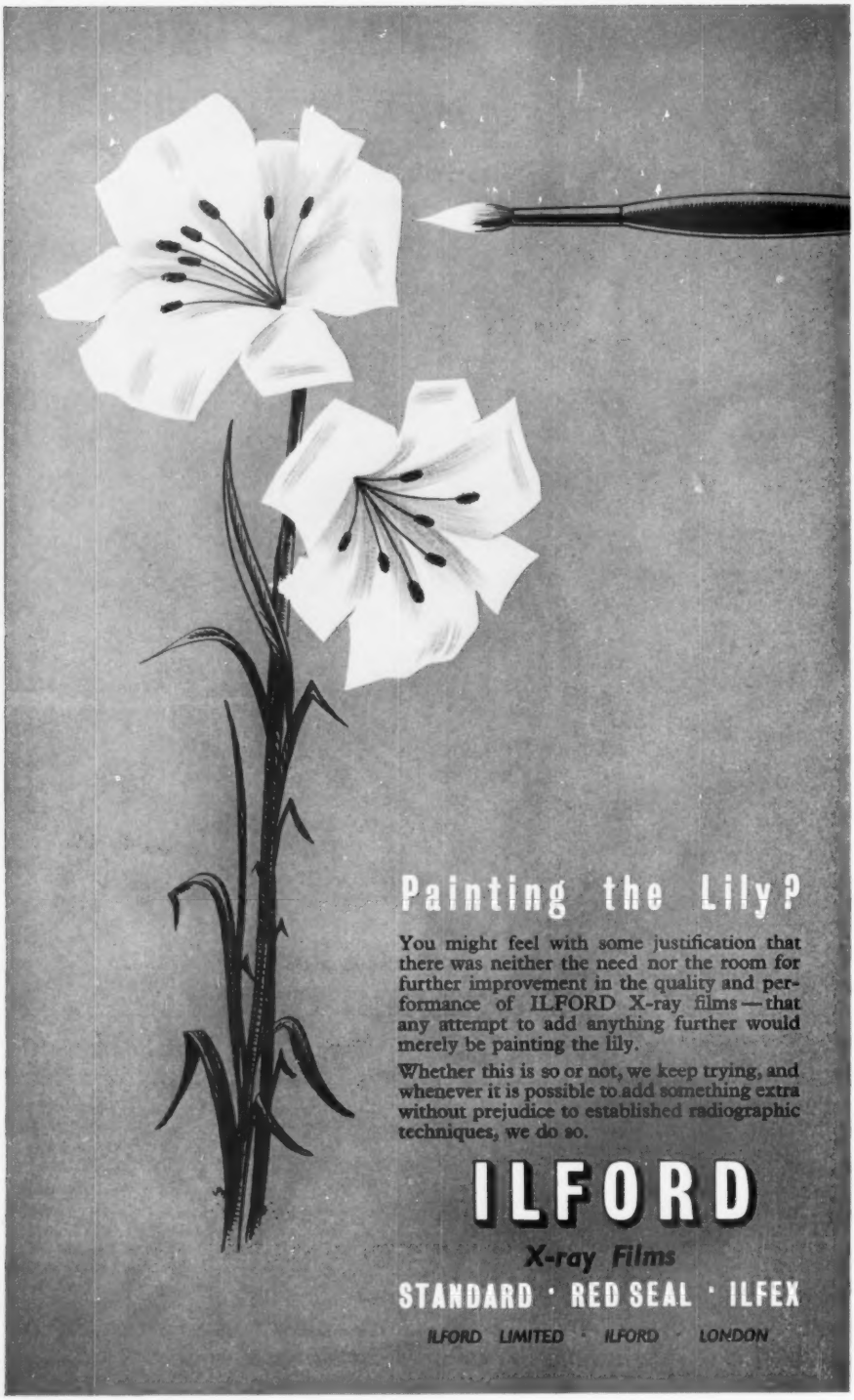
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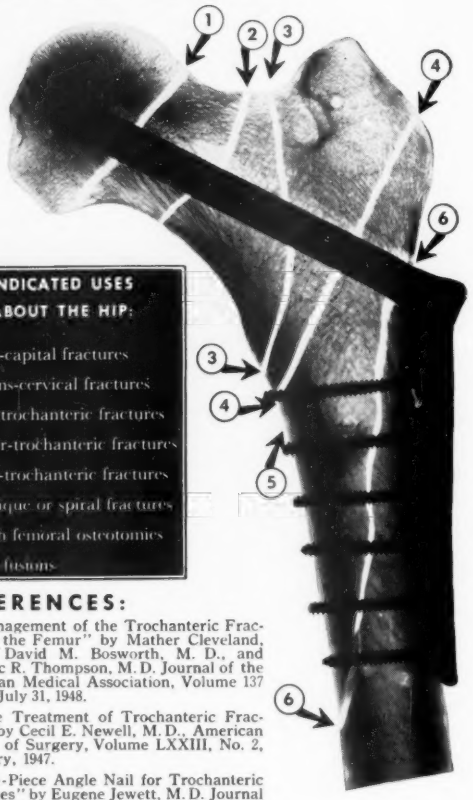

INDICATED USES ABOUT THE HIP:

1 Sub-capital fractures
2 Trans-cervical fractures
3 Per-trochanteric fractures
4 Inter-trochanteric fractures
5 Sub-trochanteric fractures
6 Oblique or spiral fractures
7 High femoral osteotomies
8 Hip fusions

REFERENCES:

*1. "Management of the Trochanteric Fracture of the Femur" by Mather Cleveland, M. D., David M. Bosworth, M. D., and Frederic R. Thompson, M. D. Journal of the American Medical Association, Volume 137 No. 14, July 31, 1948.

2. "The Treatment of Trochanteric Fractures" by Cecil E. Newell, M. D., American Journal of Surgery, Volume LXXIII, No. 2, February, 1947.

3. "One-Piece Angle Nail for Trochanteric Fractures" by Eugene Jewett, M. D. Journal of Bone and Joint Surgery, Volume 23 No. 4, October, 1941.

4. "The Treatment of Intertrochanteric Fractures of the Femur" by Walter G. Stuck, M.D. Surgery, Volume 15 No. 2, February, 1944.

5. "Introchanteric Fractures of the Femur" by Mather Cleveland, M. D., David M. Bosworth, M. D. and Frederic R. Thompson, M. D. The Journal of Bone and Joint Surgery, Volume 29 No. 4, October, 1947.

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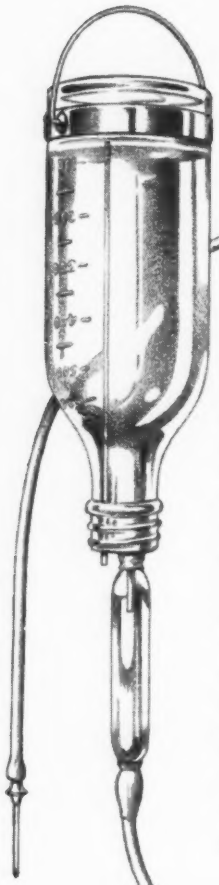

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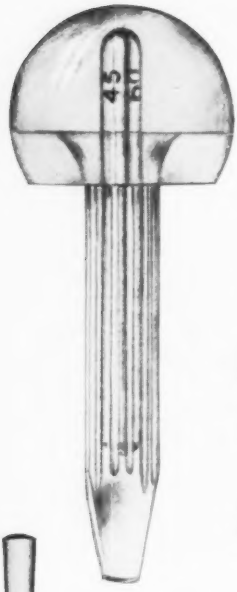

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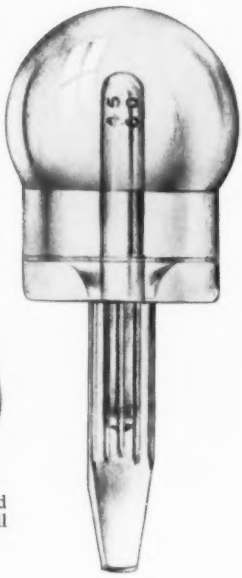

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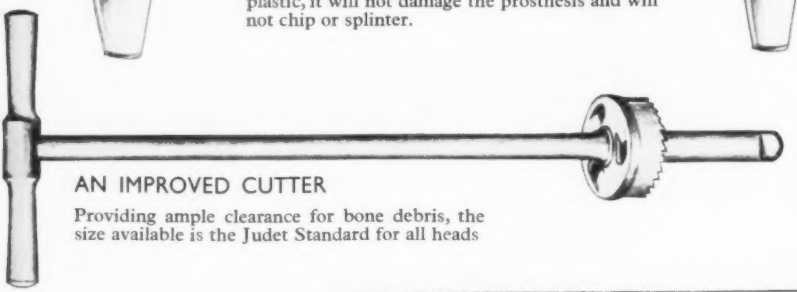

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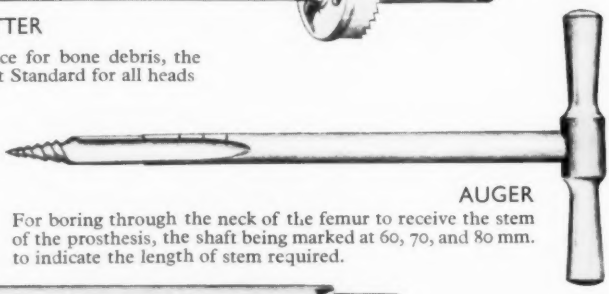

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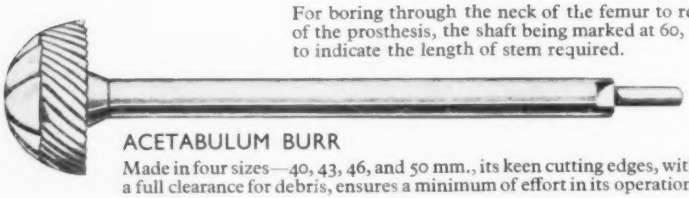

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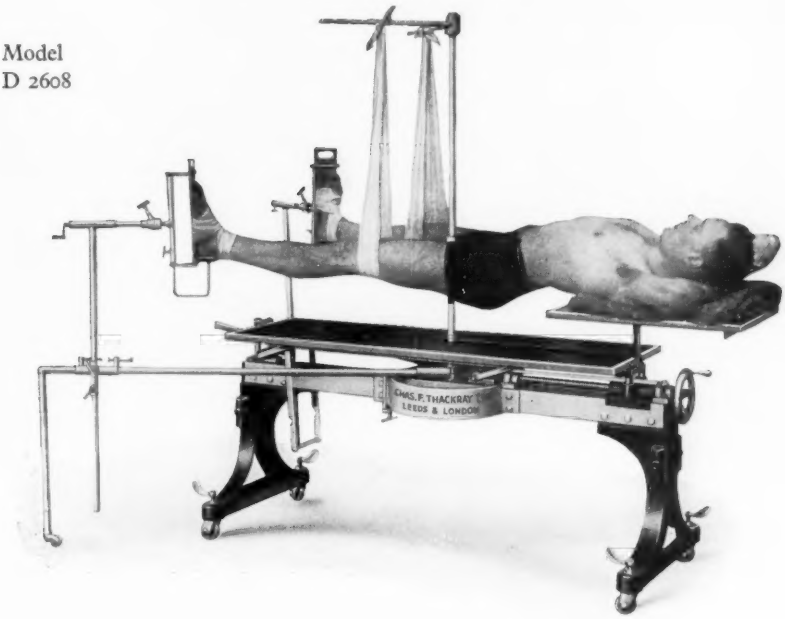

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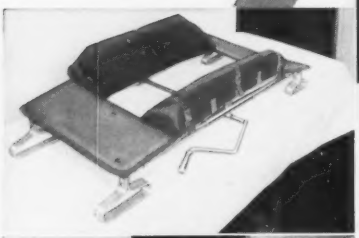

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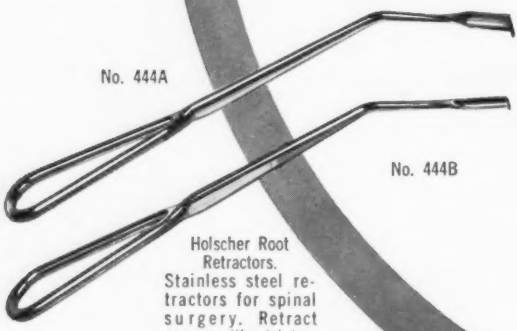

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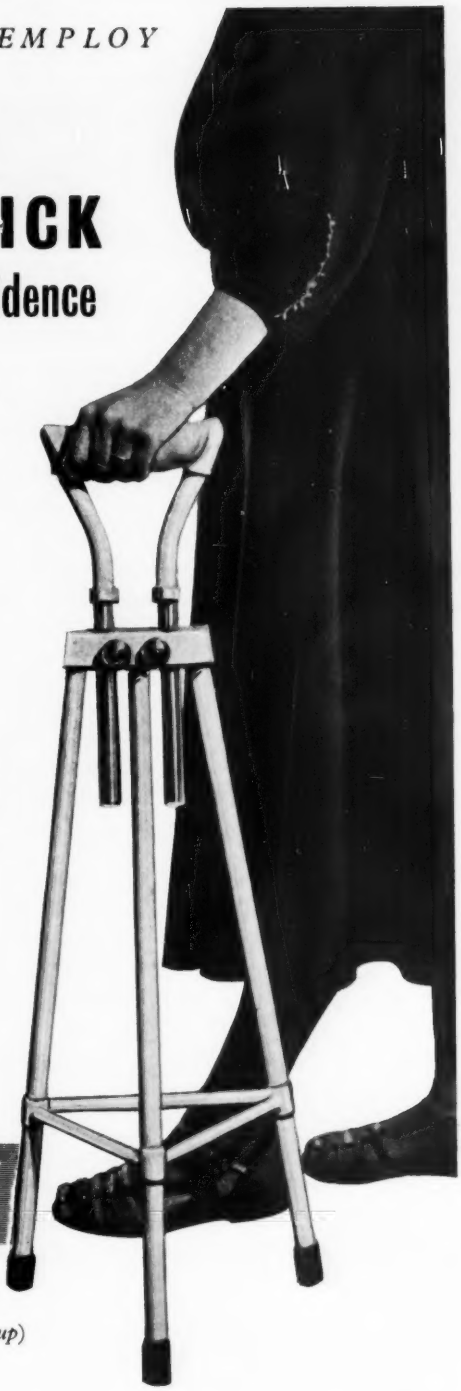

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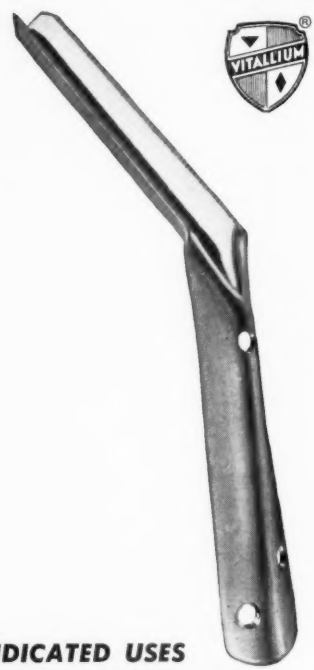

INDICATED USES ABOUT THE HIP

1. Sub-capital fractures
2. Trans-cervical fractures
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5. Sub-trochanteric fractures
6. Oblique or spiral fractures
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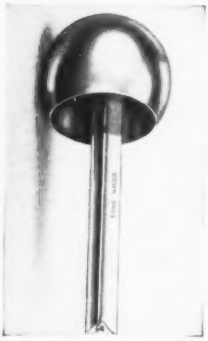

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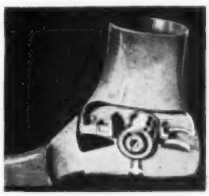

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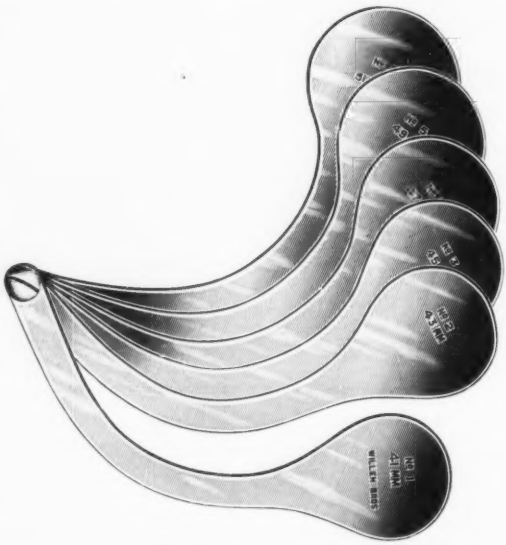

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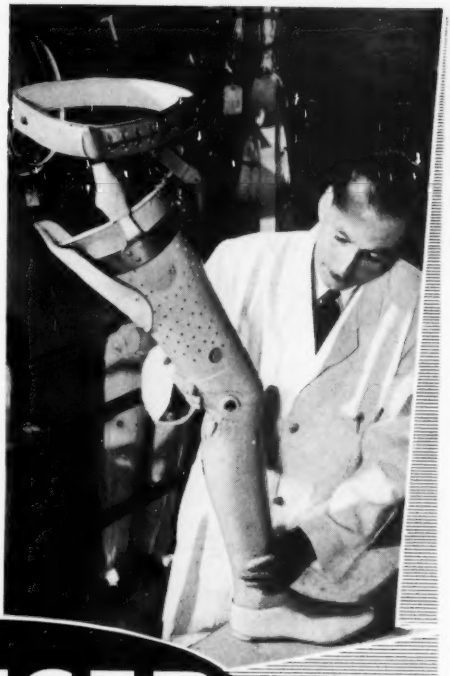

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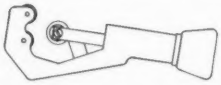

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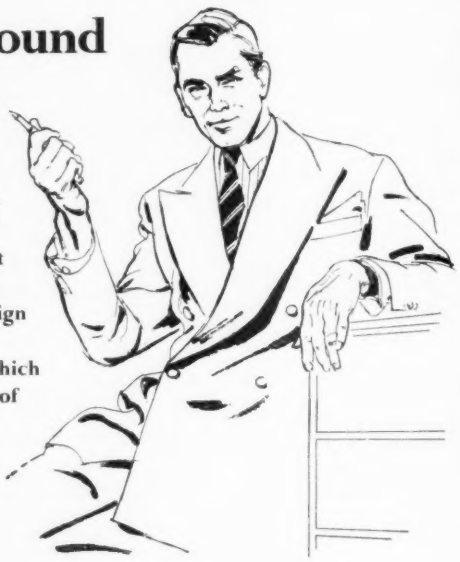

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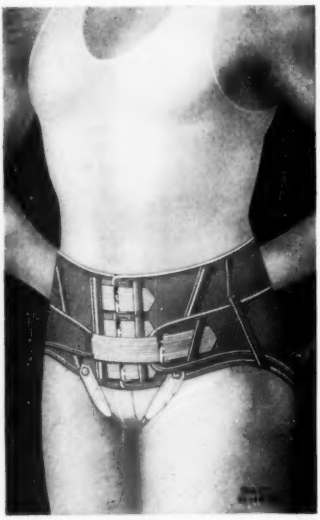

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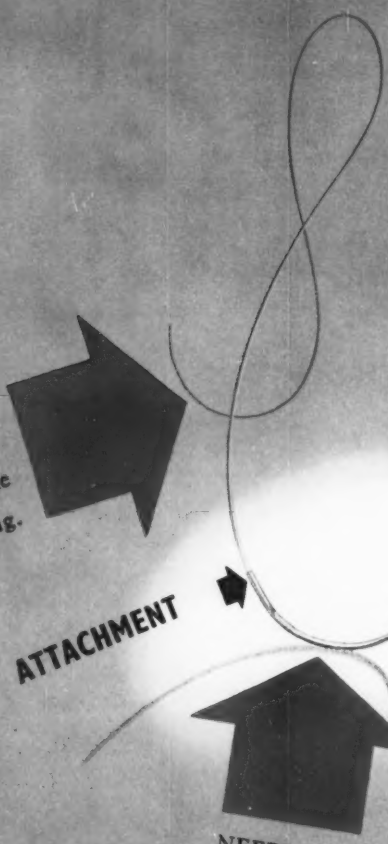

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